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Edited by

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THE TEA RESEARCH INSTITUTE.

St. Coombs, Talawakelle.

H. W. CAVE & CO., COLOMBO.

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NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle ; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

FERTILISER RATIONING, 1946

It had been hoped that the fertiliser position in 1946 would be a good deal easier ; in fact it was expected that fertiliser rationing might come to an end by the middle of the year. It now seems most unlikely that these expectations will be realised. At the moment of writing all the indications are that nitrogenous manures, particularly, ammonium sulphate, will still be in short supply and though every effort is being made to impress the authorities in the United Kingdom of the urgent necessity for increasing the nitrogen deliveries to Ceylon, it still remains quite uncertain whether the supplies asked for will be received in full.

The difficulty will be further increased by the partial substitution of Ammonium Nitrate in place of the Ammonium Sulphate. When Ammonium Nitrate was originally supplied to Ceylon, sufficient stocks of organic manures, such as groundnut cake, were available for use as conditioners or driers in the fertiliser mixtures then in use. In these circumstances no undue difficulty was experienced in storage.

This, however, will be different in the future as at present there are no stocks of Groundnut Cake available and little prospect of obtaining this from India.

Fertiliser permits for 1946 have been issued to estates and deliveries will begin early in January.

Tea.—In spite of the difficulties referred to above, quotas for 1946 allow for a 50 per cent increase in the original basic *nitrogen* allowance per acre and it is anticipated it will be possible to maintain this rate of distribution. Full details showing how the quota is made up are given on the face of the permit and the duplicate copy of the latter should be retained for reference.

The actual tonnage of manure deliveries may vary from time to time as this figure will depend on the composition of the mixture. It is hoped it may be possible, for most of the year at any rate, to use a 320 lb. mixture containing 45.32 lbs. nitrogen, 25 07 lbs. phosphoric acid and 9.0 lbs. potash. Details of the various mixtures which have been in use, with their conversion factors, are given below :—

T. 500
(Old Basic Mixture)

		lbs.
Groundnut Cake	...	430
Saphos Phosphate	...	60
Muriate of Potash	...	10
		500
giving :—		
Nitrogen	...	30.1
Phosphoric Acid	...	17.7
Potash	...	6.0

T. 240

		lbs.
Ammonium Nitrate	...	80
Organic Mixture	...	65
Saphos Phospate	...	85
Muriate of Potash	...	10
		240
giving :—		
Nitrogen	...	30.15
Phosphoric Acid	...	20.07
Potash	...	6.0

T. 300

		lbs.
Ammonium Sulphate	...	220
Saphos Phosphate	...	65
Muriate of Potash	...	15
		300
giving :—		
Nitrogen	...	45.32
Phosphoric Acid	...	19.17
Potash	...	9.00

T. 320

		lbs.
Sulphate of Ammonia	...	220
Saphos Phosphate	...	85
Muriate of Potash	...	15
		320
giving :—		
Nitrogen	...	45.32
Phosphoric Acid	...	25.07
Potash	... ...	9.0

It will be noted that while the old mixtures contained 30 lbs. nitrogen, T. 300 and T. 320 contain 45 lbs. From the point of view of nitrogen content, which is the chief factor concerned, 500 lbs. T. 500, the first basic mixture, are therefore equivalent to 240 lbs. of T. 240, 200 lbs. of T. 300 and 213.3 lbs. of T. 320.

RUBBER

No change is being made in the quotas except that, in the case of young rubber, the allowances are increased in accordance with the age of the rubber. Quotas, as before, have been issued in terms of R. 400, R. 215 and Saphos, but a more concentrated mixture, in which the nitrogen is provided by Ammonium Nitrate, is likely to be used during part of the year instead of R. 400.

CORRESPONDENCE

Correspondence in regard to *quotas* and the *issue of permits* should be addressed to the Organiser, Fertiliser Rationing, St. Coombs, Talawakelle.

Correspondence in regard to *orders* and *deliveries* should be addressed to the Fertiliser Control Bureau, P. O. Box No. 123, Colombo.

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Organiser, Fertiliser Rationing.

THE PROBLEM OF NEMATODE CONTROL IN TEA PLANTATIONS

C. H. GADD & C. A. LOOS

The two major nematode (eelworm) pests of Ceylon tea plantations are *Heterodera marioni* (Cornu) Goodey and *Pratylenchus (Anguillulina) pratensis* (de Man) Filipjev.* *Heterodera marioni,* well known as the cause of root knot diseases of numerous plants, is very destructive to tea seedlings and forms a serious nursery pest. It is also known to tea planters as the cause of large galls or root knots on *Dadap* and *Tephrosia vogelii,* two green manure plants commonly grown among tea. Although the soils of many tea fields are heavily infested by this eelworm, mature tea bushes with few exceptions rarely suffer. This fact will again be referred to later.

The disease caused by *Pratylenchus pratensis* is not so well known, partly because it is not so widespread and partly because it is not easily recognised. Gadd (1938) has published a full account of this pest and the symptoms exhibited by infested bushes. Bushes attacked by *P. pratensis* are usually unthrifty, and have a thin appearance due to deficiency of foliage, but it should be noted that other causes, *e.g.,* scarlet mite attack, often lead to similar symptoms. The only sure way of recognising the disease is by the identification of the eelworms associated with it.

HABITS

The habits of *H. marioni* and *P. pratensis* are alike in so far that both gain entry into the plant through root tips, and both spend part of their life cycle within the roots. In other respects their habits are different. *Heterodera* for instance extrudes her eggs from the root in a gelatinous mass ; so, her young hatch in the soil or in the rotting tissue of old gall, whereas *P. pratensis* lays her eggs within the root where they hatch. *H. marioni* collected from soil consist of larvae and males only whereas a collection of *P. pratensis* from soil usually consists of adult females as well as males and larvae. As *P. pratensis* is born within living roots from which all its food requirements can be obtained, it is perhaps surprising that the species is ever found in any quantity free in the soil. To explain their presence in soil it will be necessary to consider briefly the root system of the tea bush.

Tea, like other plants, absorbs its water and soil nutrients in solution through the roots. But the greater part of each root is covered by a corky layer which is impermeable to water, and a small region only, immediately behind the root tip, is free of this cork layer and so can absorb water. As the root ages, a cork layer is formed around this region also ; but in the meantime the root grows longer and a new water absorbing region is formed, always immediately behind the root tip. This process of continued growth occurs on the tap and main lateral roots which advance into new regions of soil. A tea bush, however, requires a large volume of water daily, and the absorbing areas on the main permanent roots are far too small to obtain a bush's full requirements. A large absorbing area is provided by innumerable fine roots, commonly termed "feeding roots," which can be collected in handfuls from the sites of

* In earlier publications the authors have used the name *Anguillulina pratensis* (de Mann) Goffart for this pest. Recent classification of this group of nematodes has resulted in its transfer from the genus *Anguillulina* to *Pratylenchus;* so, in future the name *Pratylenchus pratensis* (de Man) Filipjev, now generally accepted in agricultural literature, will be used for it.

healthy bushes. These feeding roots are of a much less permanent nature; they function for a time, then die and decay, and are later replaced by others. In this way. feeding roots explore the same volume of soil over and over again, whereas the permanent woody roots by continued growth tend to explore new regions. As a source of supply of water and soil nutrients, the feeding roots are of the greatest importance although their life is relatively short.

As the great bulk of water taken up at the roots is later lost from the leaves, the number of leaves a bush can carry must depend to a large extent on the number of feeding roots supplying water. Heavy root pruning results in a wilt and dropping of the leaves. It is also very probable though it is more difficult to prove, that defoliation of a bush results in the premature death of a number of feeding roots. When a bush is pruned a very large number of the feeding roots die, but new ones are formed immediately before the bursting of the buds and development of the new leaves.

With this brief sketch in mind we may consider what is likely to happen to female *P. pratensis* that enter (1) a young tap and (2) a feeding root. Entry is always obtained near the root tip in the water-absorbing area; and experiments to induce the eelworms to enter through the corky layer of the root have invariably failed. A female entering a taproot bores her way through the cells until the whole of the body is within the root where she feeds. In due course, eggs are laid and the young hatch, become adult and in turn have young. Meanwhile, the root continues growth, penetrating further into the soil; but the eelworm and her family remain relatively in the same position. As time goes on. the eelworm colony becomes larger, the region of the cortex in which they have fed dies, and a lesion is formed. These eelworms apparently do not leave the root; they merely move a little further in the cortex so that their heads always lie within living cells. Such lesions contain large numbers of eelworms but the damage they do to the bush is probably very small.

The female that enters a feeding root has no such assured future. She enters near the tip, feeds, and raises her family. But in the course of time the root begins to die and then decay. Conditions are then no longer favourable for the eelworm as there are no living cells on which to feed. Consequently the eelworms must leave that root and travel through the soil in search of others in which to live and feed. Heavy infestations of feeding roots also result in their premature death. The presence of numbers of *P. pratensis* free in soil is probably due more to the death and decay of infested feeding roots than to other causes

The number of eelworms of the species *P. pratensis* found free in soil is usually relatively small compared with the number in susceptible roots growing in that soil. This fact is well demonstrated by the following experiment: A tea seedling was established in a six-inch pot, and 200 specimens of *P. pratensis* from a tea root were added to the soil. Five months later only 190 eelworms were recovered from the soil but over 6,000 were obtained from the roots. The eelworms were collected from the roots by immersing them in water for seven days, but by no means all the eelworms (probably not more than half) were recovered by that method. Had the count been made after pruning the plant and after the premature death of feeding roots, the ratio of eelworms in roots to the number free in the soil would probably have been much narrower.

Soil in which plants infested by *H. marioni* are growing, usually contains a large number of larvae due to the fact that the eggs are extruded in masses from the roots. Entry into the roots is made by

larvae ; the females after taking up a feeding position do not move from that position; they die after extruding their egg masses.

Neither *P. pratensis* nor *H. marioni* can obtain proper nutrition while living free in the soil ; yet they can survive long periods of starvation (Gadd, 1942). Specimens of *A. pratensis* have survived for 8 months in damp soil from which all living plants, from which food might be obtained, have been rigidly excluded.

CONTROL MEASURES

Control measures, to be rational, must be based on known facts regarding the life-history of the pest and host. From what has already been said, it will be evident that in any infested planted area, the eelworms will be located in the roots of growing plants and free in the soil. For obvious reasons it would seem easier to kill the pest in the soil than to free living plants without damaging them.

Disinfection and Sterilisation.—Plant-parasitic nematodes living entirely within roots or other plant parts, are well protected against their natural enemies, and are difficult to bring into contact with poisons. In order that a poison should reach them it would have to be absorbed by the plant without injury, and then conveyed to the site of the parasites in sufficient quantity to be toxic. Eelworms, however, appear to be highly resistant to most known poisons, and there seems little probability at present that one will be found harmless both to the plant and the consumers of the crop, yet deadly to the pests within the plant tissues.

The one sure way of destroying parasitic nematodes within plant tissues is by killing, preferably by fire, the plant itself and with it the harboured pest. Plant pathologists have as a goal the cure of plants, particularly perennials like tea to which such radical killing methods cannot easily be applied ; yet little is known of plant therapeutics though considerable advance in disease control has been made in the recent years by nutritional means. At present, however, no curative treatment is known by which a *growing* plant can be freed of nematode pests, nor have general observations suggested favourable lines for investigation.

Plant parasitic eelworms cannot survive exposure to high temperatures, and use has been made of this fact for ridding dormant planting material, *e.g.*, bulbs (Goodey, 1933) and chrysanthemum stools prior to taking cuttings (Hodson, 1933), of nematode pests hidden within their tissues. Considerable care is necessary for efficient treatment because too high a temperature will kill the plants, whereas too low a temperature or too short an exposure to the correct temperature (110°F) will allow the eelworms to survive. The margin between the too high and too low temperatures is never very large. This method of control is of particular value when suspect material has to be planted on clean ground, but if the soil is heavily infested the treatment of the planting material can have but limited value.

Heat can more easily be applied to kill eelworms in soil from which living plants have been removed, as higher temperatures can be used. Steam is commonly used for the purpose. Steam sterilisation is of particular value for green house soils where one can ensure that the temperature of all the soil to be used is raised to the required degree, and so eradicate the pest. But equal success cannot be achieved with field soils. Eelworm populations of field soils can be materially reduced by steam sterilisation but complete eradication cannot be achieved. A reduction of the population may be sufficient to allow of a profitable temporary crop being taken, but when the crop plant is perennial, like tea, nothing short of

complete eradication of the pest is likely to prove of permanent value. A small population would soon increase to gigantic proportions on the roots of the susceptible perennial plants, and the soil would become as heavily infested as before treatment.

Much that has been said of steam sterilisation applies equally to the use of poisons for sterilising soils. It has proved impossible to obtain complete eradications of plant-parasitic nematodes from field soils by their use. Eelworms are peculiarly resistant to many poisons, so the choice for control purposes is restricted. Silver salts have proved deadly to both *H. marioni* and *P. pratensis in vitro* (Gadd, 1941) but the result when the same salts are applied to soils has been very disappointing. It will be obvious that if a poison used for soil sterilisation is also toxic to plants, the soil must be freed of the poison before plants can be grown in it. For that reason volatile substances are to be preferred. The best known and most successful are formaldehyde and chloropicrin (Taylor, 1943).

The fact that *H. marioni* and *P. pratensis* cannot long survive desiccation has a practical value in that it affords a method of freeing small volumes of soil of these eelworms without the use of chemicals. Sun-drying of soil, previously sieved to remove all roots, has proved of value where seedlings are to be raised in baskets (Gadd, 1941). The soil must be spread thinly to ensure thorough drying; consequently a large drying area is required for a relatively small volume of soil. This, together with the labour involved, reduces the value of soil desiccation as a means of control on an appreciable scale.

A method of control which has the greatest value is by rotation of annual crops. A susceptible crop is grown on infested soil only at long intervals. Immune or resistant crops are grown in the intervals during which time the eelworms, owing to the absence of susceptible roots, are starved and their number reduced. Again, this method does not result in eradication of the pests though it reduces the parasitic nematode population sufficiently to enable one susceptible crop to be grown successfully. The method is, of course, impossible with a permanent crop like tea, nor does it suggest the possibility of starving the nematodes completely from infested areas from which tea has been removed. Mention has already been made of the lengthy period that *P. pratensis* can survive starvation. *H. marioni* is probably even more difficult to starve out of soil because it has so many more host plants on which it may survive. During the starvation period the soil must be kept free of all plant growth as the presence of susceptible plants among the weeds would undo any beneficial effect achieved by starvation.

Natural Enemies.—Due largely to the medium in which they live, relatively little is known of the natural enemies of soil-eelworms. So far as is at present known their chief enemies are predatory nematodes belonging to the genera *Dorylaimus, Mononchus* and *Diplogaster,* certain fungi, and disease causing organisms like Sporozoa.

Every fertile soil contains numerous species of nematodes in large numbers, none of which may be harmful to plants. The number of known plant-parasitic species is relatively small though they receive most attention in agricultural literature. Many species feed on bacteria and decaying vegetable and animal matter, and these, as might be expected, are most numerous. There are, however, other species which prey on their own kind. Their food may be described generally as living animal matter, or more specifically, as nematodes, rotifers and other microscopic soil organisms. So far as can

be ascertained such predacious nematodes do not chase their prey, but take what happens to pass within reach, and they do not seem to have any great preference for particular species. One cannot, for instance, induce a *Mononchus* to feed only on *H. marioni* or *A. pratensis* when other species are available and easily obtained. Under natural conditions the bulk of the predators' food is obtained from non-parasitic species which spend their whole life cycle free in the soil. No species of predator is known to the writer to enter infested roots to feed on the parasites there. Nevertheless, when such parasites pass through the soil they are likely to become prey to the predator. The activities of some predatory nematodes have been watched under laboratory conditions, and the junior author has in his collection specimens of *Mononchus* in the act of swallowing *A. pratensis* worms.

Little is known concerning the value of predatory nematodes in the control of plant parasitic species. Thorne (1927) in a study of the economic importance of species of *Mononchus* estimated their numbers, in the sugar-beet growing sections of Utah and Southern Idaho infested with *Heterodera schachtii,* to vary from a few specimens only to nearly 300,000,000 per acre. To be of much economic importance their number must be great. Species of *Mononchus, Dorylaimus* and *Diplogaster* are found in Ceylon tea soils but in no instance have they occurred in such numbers as to constitute a menace to other nematode populations.

Among soil fungi are a number of species highly specialised for catching nematodes by means of traps of various sorts. A trapped eelworm rarely escapes and its body is used by the fungus as food. A parasitic eelworm moving freely through the soil is as likely to be caught in a trap as is a non-parasitic species, but it is only when moving through soil that the parasitic species runs that risk. The longer a parasite remains free in the soil, the greater the total risk. Of *H. marioni,* only larvae and the occasional male can be caught, but adult *P. pratensis* of both sexes as well as larvae may be trapped when they leave dying or dead feeding roots and move towards living roots.

The number of eelworm-consuming fungi in a soil will depend to a large extent upon the size of the eelworm population; the greater the number of nematodes the greater the number of fungi which can live on them. The simplest way of increasing the non-parasitic eelworm population of a soil is by the addition of decaying organic matter. It has long been known that the addition of organic matter to soil often gives beneficial results in nematode control, and Lindford *et al* (1938) have indicated how that control operates. Decomposition of organic matter results in a greatly increased population of total nematodes in the soil, and this in turn supports the building up of large populations of plant and animal forms destructive to nematodes, including nema-capturing fungi, predacious nematodes, and predacious mites. These collectively attacking various types of nematodes, destroy larvae of the root-knot nematodes and other parasitic species as well as the free-living forms which comprise the greater part of the total nematode population in the soil during early weeks of decomposition. Consistently in five experiments decomposition of large amounts of organic matter in soil was associated with reduction in numbers of *Heterodera marioni* galls on roots of indicator cowpeas.

Lindford *et al* pointed out quite clearly that their experiments afford no prospect of eradication of the root knot nematode or other parasitic eelworm and that nothing less than eradication is sufficient for some purposes, as in nurseries and propagating beds. However, with the present unsatisfactory position of eelworm control for permanent crops any method offering pros-

pects of amelioration is worthy of consideration, and this one is worthy of attention. Heavy green manuring at any time is likely to prove of value against *H. marioni* because the larvae are always present in infested soil, but more apparent benefit can be obtained when planting susceptible plants, *e.g.*, dadaps, by using large quantities of decaying vegetable matter in the supply holes. As regards its value against *P. pratensis* little is known from experiment, but from what has been said earlier regarding the effect of pruning on feeding roots and the escape of the nematodes from dying roots, it would appear that the best time for applying heavy doses of green manure to tea infested by this pest would be shortly after pruning.

During his investigations of the economic importance of some *Mononchs*, Thorne (1927) noted that their populations varied greatly from year to year. Two species were found to be attacked by sporozoan parasites that sterilise them and so reduce their numbers. Other undetermined causes also greatly reduced the numbers of other species, and in one field practically exterminated a species. In a later paper, he (Thorne 1940) reported the discovery of another species of sporozoan which attacked *Pratylenchus pratensis*. At the time of collection the nematodes were living free in the soil, having left maturing cotton roots, and 66 per cent of the individuals were parasitised.

A similar sporozoan parasite of *A. pratensis* has been observed once only in Ceylon, and then a few worms only were seen to be infested. A careful search is made for these and other parasites whenever *A. pratensis* infested soil is examined, and from general observations it would appear that the species is particularly free from attack by disease-causing organisms. Nevertheless the discovery that one of our most serious plant-infesting nematodes can be severely attacked by a parasite is most encouraging and gives rise to the hope that at some time such parasites may be utilised in developing a natural control of the pest.

Host Immunity.—Plant parasitic nematodes have great ability to find and select their proper host plant. Some species, like *H. marioni* are known to attack a large number of different plant species, which are called their hosts, whereas others have only one known host plant. The chief species of plant-infesting nemas. including *A. pratensis* have many hosts. Steiner (1925) has described their habits as follows: "If a number of different host plants are growing on a given soil area, the nemas in the soil will always find out and attack the one they like best, leaving the others unharmed, even though they too are favoured host plants of that species of nemas." This phenomenon has suggested an apparent method of control, by trapping the nematodes in a most favoured host.

For instance, many Ceylon tea fields are infested with *H. marioni* which cause disease of *Tephrosia vogelii* and *Dadaps* intergrown for green manure. *H. marioni* in a few fields is known also as pest of old tea, but from general experience *T. vogelii* is the more favoured host. When *T. vogelii* is planted in infested soil, the larvae of *H. marioni* by preference go into their roots and settle down to a sedentary life. If at this stage, before the larvae have become mature and begun to lay eggs, the *T. vogelii* plants are uprooted and destroyed a large number of parasites would be trapped and destroyed, and the soil population would be reduced accordingly. Tephrosia, however, is not intergrown with tea as a trap-crop, but as a green manure. Consequently the plants are not removed at the right time. By the time they are removed, several generations have been reared on their roots and the nema-population in the

soil nas been considerably increased. If, instead of *H. marioni*, the soil is infested with *A. pratensis*, and *T. vogelii* is interplanted with tea, the nemas would go to the tea in preference to the Tephrosia. In such circumstances Tephrosia would be useless as a trap crop.

The trap crop idea is simply to plant a highly susceptible crop in the soil and to catch as many nematodes as possible in the root system. Then comes the most important step. Before the stage of development is attained at which a new generation of nemas will develop, the plants must be killed to cause the death of the contained parasites. The time of destruction of the host plant therefore is very important. If destruction is delayed more harm than good is likely to result. *H. marioni* breeds at different rates in different hosts (Gadd, 1939) so the optimum time for lifting the trap crop has to be accurately determined.

Godfrey and Hoskins (1934) who carried out experiments with sprouted cowpea and tomato plants as trap crops to catch *Heterodera marioni* in containers showed that the largest catch was made at the first planting and that subsequent planting of trap crops recovered only low additional proportions. The third successive planting of the trap crop did not entirely eradicate the nematodes, nor did the fourth do so with absolute certainty, though remaining infestation was decidedly low. The trap crops were lifted after 30 days. The conditions of these experiments in which the root systems were limited within containers undoubtedly made for a more complete catch than would occur in open fields.

It will be evident that the correct use of a trap crop under certain circumstances may give beneficial results, but it fails to give the complete extermination necessary when a permanent crop is to be planted.

Another curious and important fact concerning the relationship between parasitic nematodes and the host plant is that if the ancestors of a population have lived for a number of generations on a single species or even variety of host plant, their descendants may not attack any other plant known to be a host; or if they do so, it will be only with difficulty and then only in small number. For instance, *Heterodera schachtii* is known to infect peas and oats as well as many other hosts. But when they live on peas alone for years they become highly specialised on that crop and will then fail to attack oats severely. As Steiner (1925) has pointed out, this fact is of great importance when studying resistance and immunity of host plants.

In an experiment to test whether certain green manures and weeds were susceptible or resistant to *A. pratensis*, the plants were established in 6-inch pots and to each were added 200 worms from tea-root cortex. The population of nematodes had passed many generations in tea and in consequence was highly specialised to that host. After six months the plant roots and soils were examined. Only in those pots in which tea seedlings had grown was there a marked increase in the parasitic nematode population and a severe infestation of the roots. Over 4,000 parasites were recovered from tea roots, whereas no other species gave more than 100, using similar methods of recovery. Obviously tea plants proved more suitable for this specialized strain of *A. pratensis* than did *T. vogelii* to mention only one of the less susceptible plants. The question arises whether the eelworms which maintained themselves on the Tephrosia roots would in the course of time, if given nothing but Tephrosia roots to live in, give rise to a strain which would prefer Tephrosia to tea. From what is known of other plant-parasitic nematodes the answer is most probably 'Yes.' For this reason Steiner recommends that perennial plants, even though they are not yet known as hosts, should rather be excluded from crop rotation in nema-infested fields, as any

nema population having the same plant at its disposal for generations may adapt itself to it.

That perhaps is counsel of perfection but it is very disheartening to a tea planter whose crop is perennial. Must then tea in nema-infested fields ultimately fail? Our knowledge of the many factors affecting the problem of host immunity, as Steiner clearly shows, is far too incomplete to afford any dogmatic answer to that question. Much more has to be learned of the immunity problem involving as it does the whole behaviour of the plant under influence of attacking nemas.

Very large areas under tea in Ceylon are infested by *Heterodera marioni* as is shown whenever *T. vogelii* is intergrown with the tea, yet with small exceptions, the tea to all appearances is unharmed. The same parasitic nematode, however, is a serious and destructive pest in tea nurseries. The evidence points to the fact that although tea in the seedling stage is susceptible to, and suffers severely from, attacks by *H. marioni* yet older tea as a rule is either less attractive or is able in some unknown way to neutralise the effect of the eelworm attack, and so escape serious damage. Evidence has been obtained that some *H. marioni* larvae do enter the roots of tea bushes, but normally they fail to cause giant cells and to complete their development. Nevertheless, in certain areas, *H. marioni* is known to cause severe damage to the roots of mature tea bushes, but such areas are extremely small when compared with the large area of *H. marioni* infested tea soils. Why then should old bushes in certain areas be susceptible while in larger areas the bushes are resistant? Is it that in certain areas a specialised race, capable of breaking down the bushes' resistance, has evolved, or is it due to a loss of the bushes' resistance due to climatic, soil or other conditions? These questions cannot be answered at present, but the facts disclose problems of considerable importance. If a specialised race has been evolved there is grave risk of its spread to other tea bushes, and there is also the probability that similar evolution is occurring in other fields. Observations over a number of years give no indication of marked spread nor have new infested areas been located. If, for unknown reasons, the natural resistance of the bushes has been broken down, the need for investigations regarding the nature of that resistance becomes obvious. At present we do not know why tea seedlings are more susceptible to attack by *H. marioni* than are the roots of older plants.

The problem with *A. pratensis* is somewhat different, as this nematode attacks seedlings and older plants alike; in fact it is better known on bushes than on seedlings. But in heavily infested fields, where the majority of the bushes are sickly, there are others apparently healthy and vigorous, giving a normal yield. Fluiter (1937) reports similar observations concerning coffee growing in soils infested by the same nematode. He states that many of the plants are killed but a good percentage seem to remain healthy, even though their roots are invaded by the parasite. By selecting these apparently resistant plants and growing them on, even in infested soil, they retain their resistance.

Experiments with tea seedlings have shown clearly that some are more resistant to and, in consequence, suffer less from attack by *A. pratensis* than others, though none has been found to be completely immune. There is no reason for belief, therefore, that any of the apparently healthy bushes growing in infested fields are entirely immune from attack either, but there is clear evidence that they are probably highly resistant.

The promising results reported with coffee give rise to the view that something

similar may be obtained with tea by the use of resistant material. At present, tea bushes are raised almost entirely from seed, and, as previously stated, tea seedlings grown from any sample of seed vary considerably in their resistance to *A. pratensis*. The continued use of seedlings can therefore lead only to the further planting of a large proportion of susceptible plants in infested areas. The alternative is to propagate vegetatively the most resistant bushes, selected in heavily infested fields.

Whether the use of resistant material will give the desired control in infested tea areas yet remains to be determined. Work has been directed towards the selection and propagation of resistant bushes preliminary to the planting of selected material in an infested area, but considerable time must elapse before the results can be known.

SUMMARY

The problem of nematode control in tea areas is discussed in relation to the two pests *Pratylenchus (Anguillulina) pratensis* and *Heterodera marioni* and is shown to be one of great difficulty. Methods which have considerable value where annual crops are concerned have relatively small value for permanent crops like tea, mainly because none has yet been found which will completely eradicate the pests from growing plants or from field soils. Many methods of plant and soil disinfection are discussed, the value of natural enemies in biologic control is indicated, and the need for research into the host-parasite relationship is shown.

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RESEARCH IN RELATION TO ADVISORY WORK*

T. EDEN

There are two mutually exclusive heresies that continually crop up in the advisory work of the Institute. One is that a method perfected, or a discovery made, in one set of circumstances can be applied in others with equal success. The other is that every estate or district is a law unto itself and therefore generalization is impossible or unprofitable. Both of these statements are too sweeping : the truth lies somewhere in between. It is the function of scientific research not only to make, if possible. new discoveries but to trace and define the underlying similarities that exist in apparently different circumstances. Having done this, sound advisory work concentrates on applying these generalizations with such modifications as local conditions demand. I understand that in this district you are much exercised in your minds as to what application the work we do at St. Coombs has to your conditions, and I shall use my time with you today in trying to clarify this issue.

The problem is simplified for us to some extent by the fact that we are growers of a single crop. We do not have to arrange our agricultural system to include crops of widely different types and requirements. Our main concern is to fit our one crop and its cultivation into a variety of environments. Each specific environment is governed by two main factors (1) soil (2) climate which interact with one another and have a profound effect on a third, the biological factor. This factor is sometimes overlooked except in its harmful manifestations as plant disease. In this district the presence of Helopeltis is an example of a biological factor peculiar to your environment

In Ceylon the soil factor is more uniform than in many countries, and at any rate the tea districts show no tremendous differences in character of the soil. There are differences, but these are more in degree than in type. The rocks from which the soils are derived are closely related : the weathering conditions under which they have been formed are not markedly dissimilar This is very important because a uniform type of weathering will produce the same type of soil from quite different rocks. To come to practical properties, nearly all our soils are acid. They are porous and workable unless they have been grossly mismanaged. Although erosion is a serious problem our soils are only moderately erodible. They are in fact soils of good structure. Except when intensively cultivated they are low in nitrogen ; they are deficient in phosphorus but have a relative abundance of potash. We have no salt problem and as far as we know there are no marked deficiencies in the rarer mineral elements, lack of which devastates agriculture in many places. The one thoroughly objectionable soil type that is entirely detrimental to tea is that derived from limestone. There is a little of this in the northern reaches of your district, but in the tea districts as a whole it is of small importance. There are, as I said, some differences. Up-country we have no typical laterite or cabook, but agriculturally our red earth soils behave similarly though to a modified degree.

* A lecture delivered to the Morawak Korale Planters' Association on November 24th, 1945.

When we come to climate, the story is different. Small as the area under tea is, there are within it marked variations in rainfall, humidity and temperature and of these temperature is probably the most important. As regards rainfall and humidity, the perennial deep-rooting habit of tea acts as a considerable safeguard against severe loss by drought, in comparison with what happens to annual crops in like conditions. As you are aware, the greater part of the solid tissues of a plant are derived from carbon dioxide in the air. The efficiency of the process of carbon assimilation is affected both by temperature and light intensity, but the predominating factor is light intensity. Temperature does, however influence the balance between that portion of the carbon which is used for active growth and that which is held in reserve, to the detriment of the latter. To put the idea colloquially : at low elevations tea leads a more hand-to-mouth existence than in the cooler regions. I shall return to this matter later.

High temperatures speed up the chemical processes not only in the higher plants such as tea but in the host of micro-organisms associated with soils and plants. Decay, the result of micro-organic growth is accelerated. In the soil, nutrients are more easily released and wasted, and in the plant the tissues when invaded by harmful organisms decay at a greater rate. You will observe that what I am describing is not a radical change in the physiology of the tea bush but a quickening of the tempo at which it lives.

So far I have dealt in general terms with the differences in environment that are encountered in our tea districts. I propose now to deal with some of the questions that have been investigated by the Institute and to indicate what generalizations emerge from the results obtained and under what circumstances these need modification in different environments. Ever since the foundation of the Institute we have been studying the problems of manuring. From what I have said about our soils it is apparent that our experiments at St. Coombs will have a wide application. The results of these experiments have been set out in our journal and annual reports and I will merely summarise the conclusions up to date. For doses of nitrogen up to and beyond those in practical use the proportionality of dose and yield is an established fact. During the rationing period for manures the applications of nitrogen have been limited. Some people thought that such small doses would be ineffective, but experience has not proved them correct.

Phosphates do not give a response proportional to their rate of application Above 30 lb. per acre the increase is very small and economically negligible. This is in accordance with experience on similar soils all over the world. Recently an observation of a novel kind has been made in respect of phosphatic manuring : that it has a remarkable effect on weed growth. Not only is a heavy weed population encouraged by phosphates, but even when no further growth is engendered the phosphate continues to increase in the weed tissues, and, under a system of clean weeding, is consequently lost for ever to the major crop. Potash applications are just beginning to show an effect when compared with plots starved of that element for 15 years. As regards weed growth the influence of potash is negligible in promoting growth but, as with phosphate, it piles up in the tissues and is consequently a dead loss.

These general results which apply over a wide range of environments may in practice be vitiated by an unfavourable pathological factor. Evidence is accumulating from the Entomological Division that shot-hole borer, by causing large scale branch breakage and loss of plucking points, can nullify the normal responses to manuring.

Turning from the question of manuring in general to time of application in particular, this is an aspect where climate has a marked effect and where uniformity cannot be expected. Manuring in a drought is not to be recommended, because not only are the feeding roots at a minimum of activity, but those remaining in action are likely to be damaged by dry weather cultivation. Temperature also has a bearing on time of application of manures in relationship to time of pruning. At high elevations applications of manure immediately after pruning have been found to be relatively ineffective. This has been traced to the fact that a clean-pruned bush is unable to use the nitrogen supplied as manure till it has grown a good canopy of leaf. In low-country districts where clean pruning is not practised, and where the leaf canopy is quickly re-established, the necessity for delay in application of manure does not exist.

The mention of different styles of pruning takes us back to what I said previously about tea in low-country districts leading a more hand-to-mouth existence than up-country tea as regards stored food reserves. One of the first discoveries made by the Institute was that of the real cause of deaths after pruning in the low-country. Previously these deaths had been attributed to the Diplodia fungus In fact they were due to the exhaustion of reserve food supplies in the root. By clean pruning, which at the time was extensively practised at all elevations, the bushes were deprived of the very tissues which manufacture carbohydrates on which new growth after pruning depends The experiments on pruning methods which followed this discovery verified the observation that carbohydrates do not accumulate to any extent in root tissues at low elevations and suggested a method whereby these deaths could be prevented. By adopting cut-across pruning which leaves a considerable amount of foliage on the bush, or by leaving 'lung' branches to function during the critical period, deaths and dieback were successfully prevented. One or other of these methods is now standard practice at elevations below about 3,000 feet.

You have asked me to deal with the question of regeneration of tea, and this is the place to do it. I shall not allow myself to be manoeuvred into an argument as to whether a tea bush suffers from senility. but shall stick to verifiable facts. When you say that a field needs rejuvenating you mean that its bushes are low yielders ; the new wood is spindly or scarce ; the old wood is scarred with pruning cuts, and furrowed with wood rot. I spoke earlier of the increased wastage due to higher temperatures favourable to micro-organisms. To set against your quicker bush growth you have the disadvantage of more rapid wood-rot. The old practice was to cut away all the worthless wood by collar pruning and try to grow healthy wood from below the collar. The devastating results of this method have been shown on countless fields, and, bearing in mind what I have just said about starch reserves, the result is a necessary consequence of the cause. The most rational way to rejuvenate a low-country field is to grow new plants and to grow them in such a way that the possibility of invasion of pruning cuts by wood rotting fungi is minimised. I shall return to this in a moment. Here I wish to say that rejuvenation by supplying is a well nigh hopeless task if the majority of the supplies are singletons. The competition from the adjacent bushes dooms them to failure. Supplying in patches is the only reasonable alternative, but it calls for a shrewd decision as to when to sacrifice a bush which is on the down-grade but not a perfectly obvious candidate for removal.

A programme of supplying poses the question 'With what ?' The usual alternatives are stumps and seed-at-stake or bas-

ket plants. If the Institute's work on propagation of selected material by cuttings fulfils its present promise, this method of rearing young plants will have to be taken into consideration by progressive planters. Stumps have the disadvantage that by the time they have a good supply of self-supporting foliage a large centring cut is necessary, and that paves the way for wood rot. Seedlings and cuttings grow with a more favourable habit. They can be cut-across early in an operation that is little more than tipping into red wood. This besides leaving some foliage ensures that the smaller cuts have a real chance of callusing. The lower branches will thicken and in time build up a clean frame which need never be touched in its lower regions. In this way there is the possibility of eliminating the far too common sight of a bush with severe wood rot at the centre.

The proposal to use rooted cuttings as material for supplying is a novel one to which my colleague Dr. Gadd is devoting attention. In our experience growth of cuttings is equal to, if not greater than, that of seedlings of the same age when the propagating material used is good. In addition the resulting bushes are better and more uniform than those obtained from seedlings. I do not propose to deal with the technique of raising cuttings. You will find a detailed description of the method in an article in the *Tea Quarterly* by Mrs. Bond and myself. What needs to be insisted on is that though I have mentioned certain advantages that are possible with cuttings, the main factor in promoting success is to propagate a bush of good type. It is no use using cuttings from bushes chosen at random. The whole argument for 'rejuvenation' is to finish with something that is better than the original. That means selection and pre-eminently selection from your own fields. The habit of the bush, the cleanness of its wood and abundance of flushing points are prime considerations. Supplying by cuttings is not a method that can be put into large scale operation now. It needs observation and experiment which only you can do. We have demonstrated its possibilities. Its practical application will be in your hands.

RECENT VIEWS ON SOIL FERTILITY

T. EDEN

During the hundred years of scientific agricultural investigation there have been, broadly speaking, three phases in soil work. The first from 1830 to about 1870 coincided with increased interest and skill in chemistry, particularly as regards accurate analytical work. This was the period of Boussingault in Alsace, the originator of agricultural experimentation, and of Lawes and Gilbert, the giants of the period who concentrated on the nutrient problem and viewed it chemically. The second phase may be said to have developed out of Louis Pasteur's researches, though it was some fifteen to twenty years before the avenue he opened became a highway. This period was the micro-organism period, and in it the explanation of leguminous nodules was discovered. Processes in the soil which had hitherto been regarded as merely chemical were found to be the result of the activities of micro-organisms. Soil became the 'living' soil and the biological aspect of soil science was stressed. This period lasted until about the time of the First World War. It has been succeeded by the present one,

the 'soil structure' period. In using the word succeeded it is not implied that the periods superseded each other but were superimposed, the later on the previous. The soil structure emphasis now apparent in soil work is firmly linked with both the chemistry and the microbiology of the soil. The conceptions of soil structure emerged from two different kinds of investigation. They were prompted by the age-long mystery of what exactly 'tilth' in a soil is, and they received added interest from the contributions of the less practical science of pedology, which studies the condition of soil *in situ* and in relation to the soil formative processes through which it has passed.

Present-day views on tilth stress its relationship to the manner in which the individual soil particles are grouped together into more or less stable aggregates, or, more simply, crumbs. In the absence of crumbs a soil is intractable to cultivate and infertile. The crumb structure provides the best conditions for all the activities, chemical, physical (such as water retention and movement) and biological which are necessary for maintenance of fertility. In fact the view is now frequently stated that improvement in soil fertility is attributable more to improvement in the physical than in the chemical constitution of the soil. Fertility is not a simple soil question : it is a soil and root problem. By altering the structure of the soil, the structure, penetration and volume of roots is also modified and the range of exploration and exploitation increased. The chemical, physical and biological activities that nourish a plant are surface actions, *i.e.*, they occur at the surfaces where soil, air, water and root coincide. The rest of the soil is mere anchorage. Anything that increases these surface phenomena is therefore bound to have a marked effect on plant nutrition and growth. Crumb structure provides optimum conditions.

Experience and experiment have established two incontrovertible points, firstly that cultivation of various kinds can modify soil structure for better or for worse, though continued cultivation always tends to destroy that structure, and secondly, that organic matter is the most efficient structure builder. On diverse crops in very dissimilar climates and agricultural circumstances it has been convincingly shown that excessive cultivation decreases crop yield. Some of this effect must be attributed to root damage, but structure and tilth enter into the matter. The world-over attention is being directed to systems of building up organic residues and humus in soils, without which soils are infertile and a prey to the severest ravages of soil erosion.

The connection between soil cultivation and fertility has recently been spotlighted by the publication of a book by Edward Faulkner, entitled *Ploughman's Folly* that has been a best-seller in America and England. In fourteen vigorous chapters the author maintains that the plough is the 'villain of world agriculture.' He holds that though in more primitive agricultural times the plough was a great boon in tackling the everlasting weed problem, it has outlived its usefulness. By continually reversing the clod it packs organic matter at the plough-sole thereby minimising its usefulness and establishing a pan which interferes with the plant roots and with the distribution of water and nutrients to them. In place of the plough Faulkner proposes the use of the disc-harrow and other implements of novel design that will incorporate organic matter more uniformly with the surface soil without turning the soil over, and without the formation of a plough-sole. He recounts his experiences, starting on the vegetable garden and extending to a field and farm scale, whereby he produced bumper crops on previously infertile land. In passing it should be mentioned that in

America where this experiment was carried out it is usual to reap only the ears of corn and leave the straw standing. The author explains how this standing straw is incorporated into the soil. He is no advocate of a fine clean tilth. A mulch of debris on the surface or the projection of butt ends of straw he regards with favour as a protection against soil erosion and moisture loss. There is a useful point here. The present writer was in Australia during the worst drought on record, and experienced, fortunately at a respectable distance, the intensity of dust storms caused by wind erosion. Untold thousands of acres of arable land have been devastated by deposited sand. The wheat lands of Australia are predominantly farmed on a system (it would be an exaggeration to dignify it by the name of rotation) of alternate wheat and fallow. The crop is on the land for approximately six or seven months. It is then allowed to remain vacant of any crop but weeds through the dry season, and the straw and weeds provide feed for sheep. With the onset of the rains, ploughing for a bare fallow starts with the dual object of keeping down weeds and preparing the surface for the penetration of rainfall which in areas of 10 to 20 inches per annum must be carefully conserved in the soil. This involves regular ploughing and cultivation during which time, amounting to about a year, there is no protective cover. In the past season it has been the general experience that on fields that for various reasons still retained a stubble, soil erosion was reasonably controlled. This is confirmed by experimental work in Saskatchewan.

Ploughman's Folly is full of speculation accompanied by a good deal of exaggeration and in some instances positive error. The would-be scientific explanations of the undoubted facts of experience are in many cases fantastic. Capillary water plays a prominent part in the argument but is consistently confused with the moisture present in channels that are not capillaries. In fact the author's procedure is rather reminiscent of the cynic's definition of philosophy. He finds bad reasons for supporting views which he believes on quite other grounds. As examples of exaggeration are his *obiter dicta* on soil nitrogen and weeds. He is satisfied that under his system the free-living (not leguminous) nitrogen-fixing bacteria in the soil can support maximum crops without fertilizers, and he says that the weed problem can be solved in two to five years. As an antidote to this optimism we may quote the results of two weed surveys. On the continuous wheat plots at the Rothamsted Experimental Station, Drs. Brenchley and Warington discovered no less than 230 million germinable weed seeds per acre within the ploughing depth. On one of the Tea Research Institute experiments, which has been subject to the usual monthly weeding rounds, the corresponding number to a depth of six inches varied between 60 and 100 million. The Rothamsted work shows that weed seeds have a peculiar periodicity in germination. Despite apparently ideal conditions and every aid to germination, some seeds will only germinate at specific times of the year. It seems improbable, to say the least, that a weed seed population of these dimensions can be entirely brought into favourable conditions in so short a time as that stated. Some seeds have a natural dormancy of many years' duration. In the Rothamsted work two years fallowing operations reduced the weed population by only twenty per cent. Faulkner implies that the experiment stations have 'missed the bus,' to put it colloquially, in this matter of disc-harrowing and standing mulch. Here he himself is behind the times. H. H. Bennett, the Chief of the U.S.A. Soil Conservation Service, was summarising experiments on the subject a year or more before Faulkner's book was written and was describing the system as 'the most promising

conservation development of recent years.' Nevertheless when due allowances are made for the purple patches that seem bound to arise in popular descriptions of scientific subjects, this book is well worth reading as a reminder that the orthodox tradition is not sacrosanct.

From Russia and England come evidences of new and in some respects challenging views on the part played by organic matter in producing good soil structure. The old answer that humus is the chief factor does not seem to fit all the facts. For some time Russian workers noticeably Geltzer have been stressing the view that the part played by organic matter is more active when it is in process of decomposition than when it has disintegrated to humus proper. We know that vegetable remains break down under a process of microbiological fermentation when they are turned into the ground, and that this is accompanied by the formation of a sticky mucus. It is interesting to speculate on what part this mucus plays in the formation of soil crumbs. So far there has been no direct experimental determination of the process. Attempts in these laboratories to follow crumb formation when green manures were incorporated in soil failed to show any measurable effect during decomposition, but it is likely that in this instance the absence of effect was due to over-riding soil peculiarities. In Uganda, rapidly decomposing green manures, and composts past the fermentable stage have both failed to improve soil structure. It is not suggested that green manures are therefore without value in a soil, but that their beneficial effect is not one of structure-building.

The most recent Russian and English work, supplemented in Uganda, shows that the growing of crops improves structure and that their root action is the feature of prime importance. No organic matter can become more intimately mixed with the soil than that derived from roots. Moreover, it has been shown that in the immediate neighbourhood of roots bacterial action is more intense than elsewhere. All roots are not of equal power in encouraging good structure ; for example, leguminous species are less good than grasses, though a mixture of both is better than either separately. In dry climates it takes about four years for a grass sward to give the soil beneath it a good structure, and in humid temperate regions the process reaches its optimum in two years. When, by cultivation, the process is reversed, about the same length of time sees the complete loss of such improvement as has been achieved. On the basis of these investigations and much practical experience, particularly in war-time England, an extension of 'alternate-husbandry' is now being advocated. This consists of growing an arable grass crop for a period of years, and then turning the land to the production of other arable crops such as corn and roots before reverting once more to the arable grass or 'ley.' These leys produce better food for stock and greater quantities than run-out pasture, and their soil structure-building capacity is greater. It is point of special interest that the soil improvement is most marked if leys are ploughed before they begin to fall-off in production.

Here are two promising systems of cultivation which as yet do not dovetail into each other. Without using the 'villain of world agriculture it does not appear that alternate-husbandry can make much progress, but it is possible to see prospects of using the plough on leys and withholding it on other crops.

What lessons are there to be learned from these experiences for those who are engaged in tropical agriculture, particularly when engaged in plantation agriculture with perennial crops ? As far as general cropping with annual species is concerned

the Uganda work gives the plain lead for similar trials here, but our particular problem is different. We already have receded considerably from the position of intensive (and in the writer's opinion, unnecessary) cultivation. The combined agencies of tea, green manures and, be it admitted, weeds, keep our top soils very adequately filled with roots. We do not know how their efficiency compares with grass, or whether the tougher nature of tea roots is more beneficial for soil structure than the softer character of herbaceous species; but the fact that our soil volume is permanently occupied by roots in various stages of growth and decay may reasonably be put to the credit of our agricultural system. It may be that the most important part of our green manure crops is the root system and that a mulch of loppings is, on the long view, as beneficial as forking-in, despite the fact that some nutrient loss is inevitable. In other words, that mulch *qua* mulch, if it is a *permanent* feature, may have a value as soil protection to compensate for the aforementioned nutrient loss. Our system of envelope forking if carried out on the contour is quite in accordance with the newer views about keeping a broken surface on land to restrain water and wind erosion. It seems unlikely that we can ever make use of a grass cover in conjunction with a crop like tea though such covers have been a standard practice in orchards. Be that as it may, the work described in this article gives an added stimulus to future research on cultivation, roots and green manures.

A REVIEW OF ROLLING METHODS IN TEA MANUFACTURE

J. LAMB

Investigations on the rolling of tea have followed two main lines. On the one hand, traditional methods have been studied with a view to understanding the mechanics, the chemistry, and the physics of the process with a view to ultimate improvement of efficiency. On the other hand, methods radically different to the traditional methods have also been explored with the object of simplification and cheapening of the cumbrous traditional methods which, even at present, are no more than mechanised versions of the hand rolling methods practised for centuries. This review is therefore divided into two sections :—

Section One.—Traditional rolling methods.

Section Two.—Modern attempts to depart from traditional rolling methods.

SECTION I—TRADITIONAL ROLLING METHODS

Under the heading of "Studies on the Rolling of Tea" *(Tea Quarterly,* 1938, Vol. XI, p. 131) I described our rolling experiments up to 1938. After stressing the utmost importance of carefully planned rolling programmes, the principal conclusions arrived at up to that time were, to quote paragraphs 7 and 8 of "Summary and conclusions."

"Paragraph 7.—The application of heavy pressure to force dhool out-turn is undesirable. The explanation advanced is

that very heavy pressure impedes circulation of leaf in the jacket and defeats its own object since the principle of normal tea rolling is the twisting action to which the leaf is subjected and this cannot be provided correctly without circulation of leaf.

Paragraph 8.—" 'Twisting' battens are preferable for early rolling. The 'cutting' type of battens should be used for reducing the bulk of later rolls."

These conclusions stand fast and whatever developments are described later it is essential to remember that it is the circulation of leaf which provides twist, and that it is this twisting action which wrings juice out of the leaf (like water from a damp cloth). The action is slow and is only effective on relatively intact leaf. As soon as leaf is cut into dhool the twisting action becomes ineffective and it follows that rollers which give a high percentage of dhool in the first roll cannot be effective. In 1938 my idea of requirements was expressed as follows :—

"The ideal batten, at least for preliminary rolls, is one which would allow considerable pressure to be applied without excessive dhool formation and without restriction of circulation. An examination of the various types available was commenced in order to collect information on this matter. It is hoped that it will eventually be possible to design a batten which will meet these requirements and at the same time prevent throw-out."

Practically the whole of subsequent developments have depended on a chance observation during the course of the investigation of the various available types of battens. To quote again from "Studies on the Rolling of Tea." "Recently we commenced investigation of a type of batten very widely used which is even more severe than type X and the danger inherent in reference to batten types by name is very well illustrated by the enormous difference in performance when the battens on the door were changed. (Note.—The makers offered three alternative arrangements on the door). Aluminium battens on the door were substituted by similarly shaped and sized battens of teak and the result was that the dhool percentage fell as follows."

	No Pressure	Pressure applied by 1st set of weights.
Before alteration to door battens ...	21% dhool	29% dhool
After alteration to door battens ...	8% „	16% „

From the relatively high wear and tear over the door area we had suspected that a good deal of the work was restricted to this area, but this chance observation indicated that the design of the battens in the centre of the table was more important than was first supposed. In 1939 we commenced a detailed investigation on batten action starting from a plain table and adding battens in stages from the centre outwards. Quoting from our Annual Report for 1939 : "Since the twisting action of normal battens is undoubtedly responsible for the main changes in the rolling process it is considered desirable to study the factors involved in this action. We have been fortunate in receiving a kind offer from Messrs. the Colombo Commercial Co., Ltd. to make for us a number of different types of tables and battens as our experiments progress and in this we have the very able advice of Mr. F. J. Whitehead. Accordingly we have started from a plain table without battens or obstruction of any

kind and are adding various types of projections starting from the centre of the table where, as previously reported, the larger proportion of batten action takes place." A large number of different cones both smooth and grooved as well as a hexagon and other solid figures were tried out in 1939 and 1940.

At this stage it is desirable to refer to the development of commercial types of batten which exploit this zone of activity in the centre of the table. In addition to assisting us as described above, the Colombo Commercial Co. have carried out their own experiments and have developed "Column Rolling." Again, working quite independently, Messrs. Keel, Craig & Baker developed "K'bacra Cone Rolling" which is marketed by Messrs. Davidson & Co. Actually we only learnt of Messrs. Keel, Craig & Baker's experiments in 1944 and of Messrs. the Colombo Commercial Co.'s "Column" device a little later. Since then we have had the much appreciated opportunity for testing both devices on our experimental rollers and it is most interesting to find how similar are the conclusions drawn by these three independent investigators. Our own experiments have been sadly impeded by the war through absence on military duties, mechanical difficulties and restriction of facilities for getting samples tasted.

To return to the course of our own experiments. The discovery of this active zone at the centre of the table coincided with our experiments with the Clivemeare Roller which have been reported in the *Tea Quarterly* and will be referred to in detail in the second part of this review. The Clivemeare experiments strongly suggested the possibilities for simplification and reduction of rolling time, and our own experiments rather concentrated on the exploitation of what I have referred to as the "Active Zone" in a roller with the object of increasing efficiency rather than bringing about any particular improvement in teas manufactured. Thus in the Annual Report for 1940 I stated: "There is no apparent reason why twisting should take three or four operations of half-an-hour each to work the leaf into the desired condition and the subsequent cutting operation need not be prolonged. Roller tables and battens designed to give the maximum twisting or maximum cutting effect may therefore allow a more rapid completion of the rolling process with improvement in fermentation similar to that obtained in the Clivemeare process, and, at the same time, enable the orthodox appearance of the leaf to be retained." In the Annual Reports for 1942 and 1943 we reported the results of a large number of experiments designed to explore the possibilities of reducing the number of rolls by making the best use of twisting and cutting battens and increasing rolling effect by devices such as the Clivemeare Roller and "Plain Table Rollers," *i.e.*, devices exploiting the active zone in the centre of the table. Softer withers were employed when using combinations of ordinary rollers with the Clivemeare Roller or combinations of Clivemeare plus plain table rollers. Heavy pressure on ordinary rollers with shortening of the fermentation period was also investigated.

Employing normal rollers only, it was found possible to obtain good results from three-roll programmes. The teas from the three-roll programmes were required to be slightly better or equal to those from a standard five-roll programme.

At this stage of our experiments the practice of sending teas to London had to be entirely abandoned and it was no longer possible to submit teas to a "Team" of Colombo Tasters. However, in spite of difficulties, individual Colombo Tasters were kind enough to deal with experimental samples and it was possible to get the

opinion of a broker and a buyer. In all our further experiments the aim was to produce teas at least equal to those produced by a standard five-roll programme on ordinary standard types of battens Having succeeded in producing normal teas in three rolls by making the best use of twisting and cutting battens, it became desirable to explore the possibilities of further simplification by a modification of battens. It was known that almost any projection on the door would produce dhool even if the rest of the table was quite plain. Also, it was easy to produce high percentages of dhool by using devices with sharp edges. For instance a device shaped like a cotton reel (Fig. 1), comparatively very small in size, gave 78 per cent of dhool in one 30-minute roll. Teas manufactured in this manner, however, were choppy and flaky. Against this, a good circulation could be obtained with any smooth comparatively shallow projection but dhool out-turn was very poor so long as the device was smooth. By employing the pressure cap these smooth projections could be forced to produce dhool but it was of a flaky and choppy nature and was obviously produced by dragging a block of leaf compressed in the jacket by the pressure cap over and over the table. The action under these circumstances was almost entirely abrasive. By restricting battens to the centre of the table we had discovered types which gave only twisting or only cutting action and to that extent clarified the whole position with regard to the mechanics of rolling. It became evident that the commonly used batten arrangements (depending almost entirely on the door battens and on the arrangement on the table immediately round the door) give a combination of twisting and cutting action. Some types accentuate twisting effect and some cutting effect, but for commercial purposes any batten in general use must produce both effects to some extent. All our experiments up to 1943 had pointed to the desirability of separate rollers for twisting and for cutting but we had not envisaged battens which produced so little dhool as the plain table and shallow cone arrangement or so much as the cotton reel device. The application of twisting action applied by a shallow cone arrangement followed by final cutting on the cotton reel fitting would no doubt have produced quite reasonable results, but even quite well twisted leaf was inclined to be rather choppy after treatment with the cotton reel and so it was considered desirable to search for a cutting device which would at least keep the twist on the leaf.

Both the cone and cotton real devices worked independently of the pressure cap. Application of pressure to the shallow cone in fact stopped circulation of leaf as already mentioned, stopped twisting action and caused the formation of choppy dhool by a mere dragging abrasive action. We had long known that the pressure cap restricted circulation and had experimented with various pressure intervals designed to alternate free and restricted circulation to the best advantage. We now began to suspect that the action of the pressure cap was almost entirely detrimental. Apparently the use of a pressure cap on tea rollers is of comparatively recent origin, the earliest rollers having an open jacket. It now appears that the introduction of the pressure cap was indeed a retrograde step. As often pointed out, the effective action of the tea roller is entirely dependent on imparting a twisting motion to the leaf. This twisting motion depends on circulation of leaf and anything which restricts circulation is detrimental. In actual fact I believe the pressure cap is a most undesirable attachment.

MECHANISM OF TEA ROLLING

The later part of the story is difficult to tell because it means summarising the results of a very large number of trial and

PLATE I

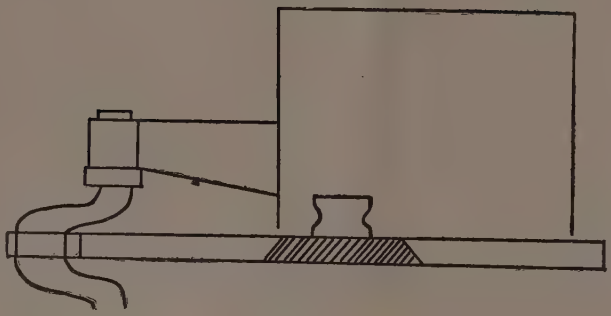

FIG I

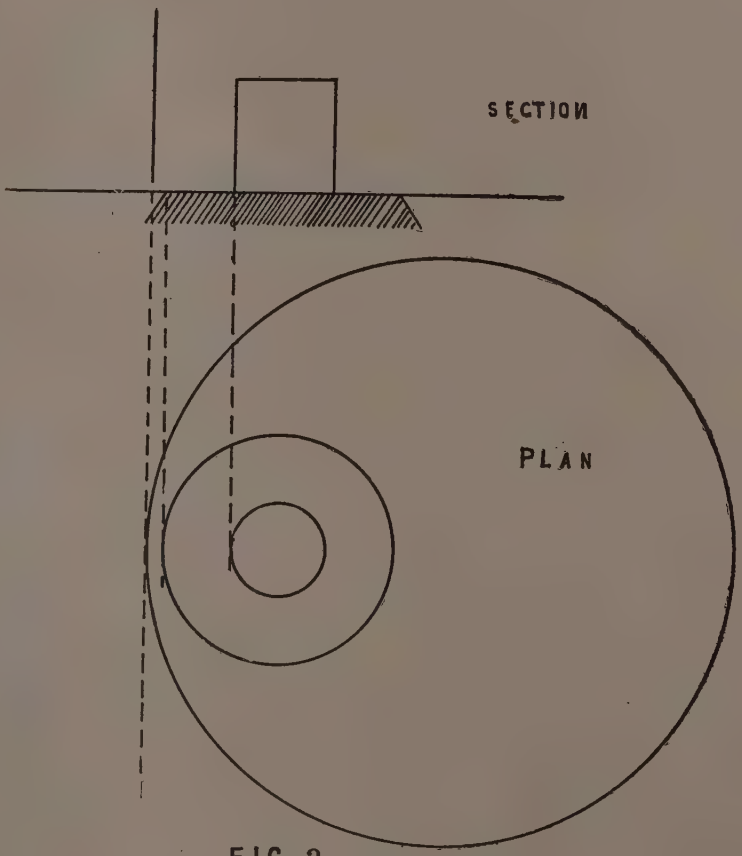

FIG 2

error experiments and also because we cannot yet give it a final happy ending. We have not reached the end of our search for the ideal arrangement but we are probably fairly close to something which will constitute a useful advance in the technique of tea rolling. From the details of the mechanism of tea rolling already discussed it is evident that circulation is considered to be one of the most important factors. Any projection from the door into the jacket will obviously have a stirring effect on the leaf. On the other hand, if this projection has any sharp edges it will cut and the trials with the cotton reel device shewed that this cutting effect can be very marked. The smooth cone was too smooth and the cotton reel too angular. A projection from the door into the jacket not only stirs the leaf but also may exert considerable pressure (in the form of a squeezing action) on any leaf caught between it and the jacket. Figure 2 illustrates this point.

This squeezing action is important. The Annual Report for 1933, p. 59, gave figures shewing actual pressure exerted by a pressure cap device. Under the hardest rolling condition the pressure exerted by the cap is only of the order of 1 lb. per sq. inch which is negligible in its effect upon leaf. The pressure cap clearly exerts its effect by stopping or restricting circulation and causing the bulk of the leaf to be dragged over the battens which are thus used as an abrasive device. The experiments with the Clivemeare roller shewed that direct pressure could be employed with advantage to liquors and infusions. The Annual Reports for 1942 and 1943 describe experiments in which this direct pressure was combined with normal rolling in an attempt to speed up the process as a whole. Teas equal or better than those from the standard five-roll programme were by this means made in two 30-minute rolls.

The application of pressure in the gap between the projection and the roller jacket therefore offered the possibility of introducing a "Clivemeare" effect in an ordinary roller. An attempt to accentuate this effect was made with a device indicated in Fig. 3. The inclined plane had the effect of concentrating the leaf on one side of the roller and feeding it into the pressure gap designed to apply the squeezing action. The theory of this device worked well but it proved to be too hard on the roller which would have to be strongly built and fitted with a counterbalanced fly wheel to counteract the irregular motion caused by this sudden resistance when the jacket closed on the pressure gap. It became obvious therefore that all projections must be of regular shape and placed centrally so that the motion in the roller is regular ; otherwise severe mechanical difficulties arise. The pressure must therefore be applied in an epicycle. Subsequent experiments have shewn the pressure gap to be the most critical part of the device. It is therefore proposed to refer to this method as Epicylic-Pressure Rolling which term will cover all our experimental devices, as well as the commercially developed fittings. Epicyclic-Pressure Rolling can be conveniently abbreviated to E. P. and covers all devices which are symmetrical in form and which are fixed in the exact centre of the roller table. The abbreviation "E.P." is preferable to the use of the loose term "cone" as a preface to this particular form of tea roller. E.P. Rolling is therefore a general term embracing the commercially developed "Pressure Column" and "K'bacra" or Cone fittings as well as all our experimental devices. The essential differences between these various devices are more in methods of fitting and support for mechanical strength than in principle.

The pressure which can be applied in the gap between the projection and the jacket is of a very much higher order than

the 1 lb. per sq. inch or so applied by the ordinary pressure cap, and opens up possibilities for considerable improvement of liquor and infusion. At the same time the smashing effect easily spoils the appearance of rolled leaf and the whole question of design eventually reduces itself to an adjustment of these two factors. Until teas are sold on the open market it will be difficult to find just what the market value of fine appearance will be in post-war circumstances and where to strike the balance between making the best possible liquors and maintaining a traditional appearance. Tradition in the appearance of black teas is the bugbear of all experimental work in tea manufacture. It is well to emphasise these antagonistic factors because, until teas are sold on a free and open market, it is impossible finally to fix or advice on any final design, and estates contemplating the conversion of normal rollers to E.P. rollers should bear this in mind. In our experiments we decided to work on designs which would give normal appearance or in which appearance is only slightly inferior to normal but more than compensated for by improvement in liquor. It must be remembered, however, that it is asking a lot of tea tasters under present circumstances to give an opinion on the extent to which improved liquors can compensate for choppy or brownish appearance. The factors influencing design of E.P. devices for further experiments were therefore :—

1. The gap between the projection and the jacket which must ensure a positive squeezing action. This action must not be severe enough to cause any marked amount of smashing and tearing.

2. The projection must be large enough to cause a rapid and complete circulation of leaf without any areas of stagnation.

3. The device must be shaped so that it does not present any severe cutting edges (at least for the first stages of the rolling programme).

The inclined plane shewn on the device illustrated in Figure 3 had a very successful scoop-like action and was incorporated in the next design. One requirement, namely that there shall not be any stagnant areas, was met by this scoop which eliminated any tendency towards caking of leaf at the foot of the projection. The projection was therefore sloped at the bottom and gradually merged into the roller table as shewn in Figure 4. As the jacket moves towards a projection with a slopping bottom, the leaf tends to be pushed up the inclined plane. In order to prevent this from nullifying the squeezing effect it was found desirable to provide a recess or pressure gap of the form shewn in Figure 3 ; only it was of course necessary to adhere to a symmetrical figure. The only possible way of doing this was to continue the slope of the inclined plane and turn it in an outward direction to form a recess as shewn in Figure 5. The figure formed by doing this again resembled the cotton reel which was found to be too vigorous in action and so it was necessary both to restrict the size of the top and to round it off. The figure so obtained resembles a collar stud and is shewn in Figure 6. Most of our experiments during the past eighteen months have been with the Collar Stud Device.

DIMENSIONS OF E. P. ROLLING FITTINGS

Having arrived at a suitable shape, the next thing was to decide on size. It is well to emphasise straight away that size will vary considerably from roller to roller, and also to stress the fact that we have not up to the present time been able to tackle the problem of working out the optimum sizes for all different types of roller. Our work has been almost entirely restricted

PLATE II.

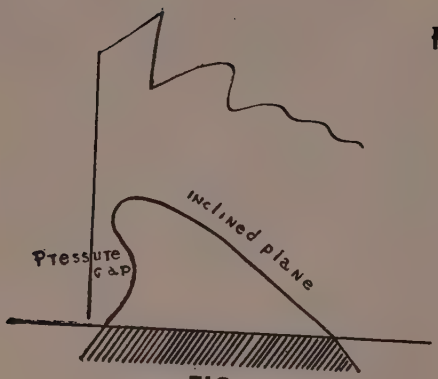

FIG. 3

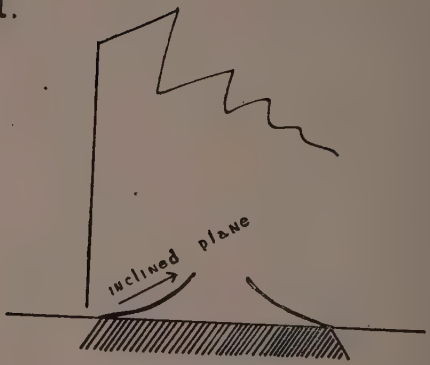

FIG. 4

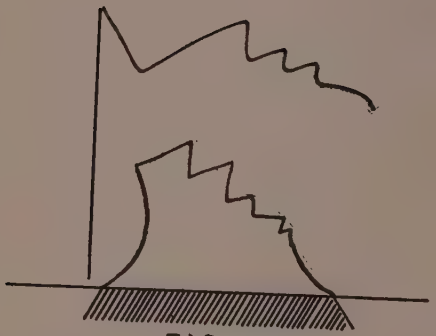

FIG. 5

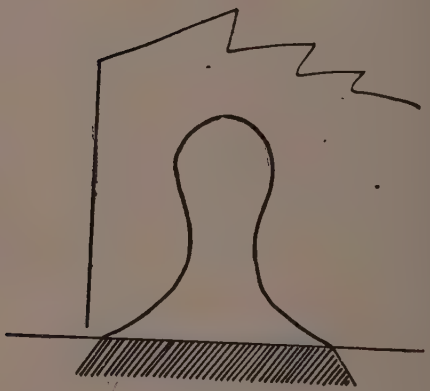

FIG. 6

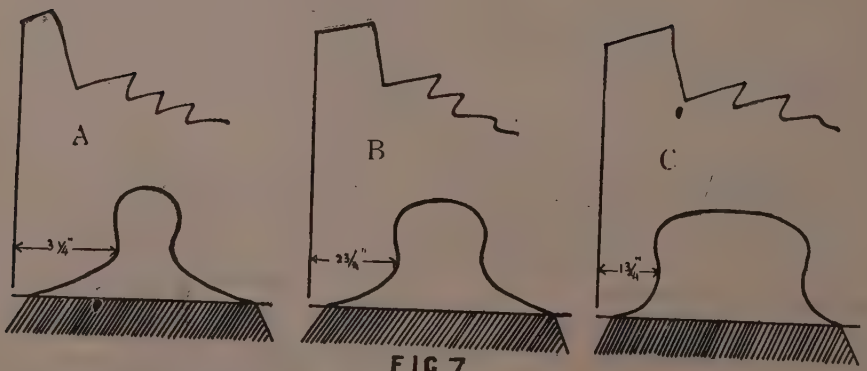

FIG. 7

TABLE IV

Speed of roller (Double Action)	Peak power consumption	Power consumption at end of 20 min. roll	Power consumption in second roll	Dhool out-turn over standard period
76 r.p.m.	2 K.W.	1.25 K.W.	0.6 K.W.	53%
49 r.p.m.	1.5 K.W.	0.75 K.W.	0.5 K.W.	47%

(The Tasters did not find any difference between the teas made).

In future experiments we must investigate slower speeds. There is nothing to be gained by running rollers above 49 r.p.m. while the initial power requirements are greatly increased by increased speed. It is possible that the initial power peak would be lower at even slower speeds which is most important because sharp peaks in power requirements are uneconomical. Certainly, it is useless to attempt to increase the efficiency of the rolling process by increasing the speed of rollers.

different methods on dhool out-turn and grading percentages was negligible. Working with a single standard charge and feeding the bulk back into the same roller after each roll breaking the results shewn in Table V were obtained. The total dhool out-turns were low because the charge fell below the normal 30 lb. in the second and third rolls. As only one roller was available at the time of the experiment it was not possible to combine charges.

TABLE V

Rolls	Total Dhool	Grading of Dhools (by Standard Method) B.O.P. %	F.P. %	Fannings %
1 × 60	60%	35	5	7
2 × 30	59%	37	9	6
3 × 20	63%	41	10	4
4 × 15	64%	38	12	4

ROLLING TIME

A total of 60 minutes' rolling time appears to be sufficient for normal results. Four different methods of use have been explored.

1. 1 × 60 min. roll
2. 2 × 30 min. rolls
3. 3 × 20 min. rolls
4. 4 × 15 min. rolls

Tasters gave slight preference to the teas from 3 × 20 minute rolls. The effect of the

The figures shewn in Table V were obtained on different days with different type of leaf. Each method of rolling was repeated at least six times and compared with a normal programme of 4 rolls on ordinary rollers. The interesting point of these experiments is the reproducibility of the results. Using a given quantity of leaf, the amount of work is directly proportional to the length of rolling and the effect on

grading percentages is constant and reliable. The actual percentages of 1st dhool were :—

(a)	4 × 15 min. rolls	32%
(b)	3 × 20 „ „	38%
(c)	2 × 30 „ „	42%
(d)	1 × 60 „ „	60%

The reduction of charge in the cases where there were second, third or fourth rolls, was automatically compensated by reduction of dhool percentage so that the total dhool production for 60 minutes rolling, whatever the rolling programme, was the same and the grading percentages unaffected. This characteristic is approximately common to all types of E.P. rollers and makes standardisation of dhool out-turn and grading percentages a simple matter in a rolling programme employing E. P. rollers.

GRADING PERCENTAGES

Over a very wide range of designs E.P. rollers give normal grading percentages. Two typical cases are shewn in Table VI where the grading percentages of teas made with a medium and severe type of collar stud projection are shewn.

ECONOMIC ASPECTS

The possible economic advantages of E.P. rolling are considerable. Our experiments have been planned to take the fullest advantage of them whilst turning out teas of quality equal to those made with rollers fitted with ordinary battens. The possible advantages are :—

(a) The output of each roller is practically doubled since rolling is completed by three 20 minute rolls (60 minutes total rolling) against the normal practice of rolling at least four periods of half-an-hour each (120 minutes total rolling).

(b) The elimination of the pressure cap and the necessity for application and release of pressure at frequent intervals makes it possible for one man to manage more than one roller. The pressure cap hinders charging, especially first rolls. and with an open top a chute can be made to discharge straight into a roller without any manual assistance and without spillage.

TABLE VI

Type	% First Dhool	% of leaf graded (Dhools)	Grading % B.O.P.	F.P.	Fannings	Dust
Collar stud, gap 3¼ in.	29	63 (from 3 rolls)	41	10	4	2
Normal battens 4 roll programme	13	59 (from 3 rolls)	38	9	6	2
Collar stud, gap 2¾ in.	59	80 (from 2 rolls)	49	10	10	3
Normal battens 4 roll programme	11	80 (from 4 rolls)	51	11	9	3

The introduction of E. P. rolling need not therefore cause any marked changes in grading percentages.

(c) Using a plain table the jacket of the roller may be lowered to within a very small clearance of the

table and any possibility of "throw-out" is eliminated. Taking this into consideration together with (b) one man should manage three rollers.

(d) The power consumption although higher than normal in first rolls is by no means increased in proportion to increased output. It has been pointed out that the power peak may be reduced by running rollers at lower speeds.

SUMMARY AND CONCLUSIONS

Emphasis in this final section must be laid upon the fact that E.P. rolling (E.P.= Epicyclic Pressure which principle is employed in "Column" and "Cone" rolling) is still in its earliest experimental stages. There is little doubt that this method will eventually displace rolling on tables studded with battens but the method may be brought into disrepute by over-hasty conversions. Our most earnest advice to any one wishing to make the change is first to be patient and secondly to consult Messrs. the Colombo Commercial Co. or Messrs. Davidson & Co. who have accumulated a considerable amount of experience of the commercial application of E.P. rolling and who have more actual experience of the *commercial* application of this method than we have at the Tea Research Institute. Our work so far has been mainly concerned with the fundamentals of rolling in general and latterly with E.P. rolling in particular as a logical development of fundamental investigations. We have no hesitation in claiming that since this fundamental investigation started we have succeeded in clearing up much of the mystery and misunderstanding which surrounded the rolling process, and even if we have not been able so far to make definite recommendations for specific designs of tea rollers, we have at least stimulated, encouraged and co-operated with both individuals and engineering firms interested in tea manufacture. We hope that our further experiments will enable us to recommend specific designs for new rollers or for alteration of existing patterns. Types of rollers now in use are however so diverse that much will depend on co-operation and advice from engineering firms concerned with tea machinery. Apart from our advice to avoid undue haste in converting rollers, there are two further conclusions which arise out of the work described in this article :—

1. The first is that the E.P. rolling is most suitable to a batch of rollers The conversion of single rollers to "see how it works" may prove most unsatisfactory. Since dhool out-turn is so dependent on charge, a properly planned rolling programme is essential. E.P. rolling is most unsuitable where the "muddle through somehow" type of rolling programme is employed and again emphasis is laid on the fact that *the rolling programme must be carefully and accurately planned.*

2. The second conclusion is that separate rollers are desirable for first and last rolls, that is for twisting and cutting. Both Messrs. Davidson & Co. and Messrs. the Colombo Commercial Co. are experimenting with devices which may be changed to enable the conversion of the roller from a twisting to a cutting type for rapid reduction of bulk. We are not entirely in agreement over this matter but engineering firms must of course supply customers' demands. We think it is wrong to expect a tea roller to do two different types of job "at the touch of a change-over lever." Almost any projection with sharp edges will give a high dhool out-turn but tend at the same time to cause a choppy

appearance. The regulation of the intensity of the pressure in the gap between the projection and the jacket, employing a relatively smooth shape of projection, is in our present view the best way of regulating dhool out-turn.

Generally speaking, estates are advised against their own experiments with E.P. rolling unless the Superintendent is prepared to spend a good deal of time on personal supervision and to keep very careful notes and records. From the description of our own experiments it will be obvious that rolling experiments are fraught with many pitfalls, and that much arduous repetition is necessary before there can be any certainty about a result. A fraction of an inch on the size of a fitting where it affects the pressure gap is very critical over a certain range and the mechanical strain is also severe unless the fittings are properly designed and supported. The average estate carpenter is unlikely to make a success of such fittings and the chances of doing severe mechanical damage are considerable. Our advice in brief is therefore to consult an engineering firm with experience of the method rather than attempt to use "home-made" fittings.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 25-5-45

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Board Room of the Ceylon Tea Propaganda Board, Colombo, on Friday, 25th May, 1945, at 2-30 p.m.

Present.—The Chairman, T. R. I. (Mr. R. C. Scott); the Hon'ble the Financial Secretary (Sir Oliver Goonetilleke, K.B.E., C.M.G.); the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.); the Chairman, Planters' Association of Ceylon (Mr. G. K. Newton); the Acting Chairman, Ceylon Estates Proprietary Association (Mr. E. E. Spencer); Major J. W. Oldfield, C.M.G., O.B.E., M.C.; Messrs. J. C. Kelly, W. H. Gourlay, F. Amarasuriya, R. C. Kannangara, M.S.C., and Dr. R. V. Norris (Director and Secretary). Mr. J. Lamb (Biochemist) was present by invitation.

Letters regretting inability to be present were tabled from Messrs. R. G. Coombe and R. Singleton Salmon.

(1). Notice convening the Meeting was read

(2). The Minutes of the Meeting of the Board held on the 22nd December, 1944, were confirmed and signed.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(a) The Chairman welcomed to the Board Mr. R. C. Kannangara, M.S.C., who had been nominated with effect from 8th April, 1945, by H. E. the Governor to represent the Smallholders in Tea, *vice* Adigar Sir T. B. Panabokke resigned.

(b) The Chairman also extended a welcome to Sir Oliver Goonetilleke on his becoming an *ex-officio* member of the Board on his appointment as Financial Secretary in place of Mr. H. J. Huxham resigned.

Mr. Scott referred to the great services Sir Oliver had rendered to the Island in his former appointment of Civil Defence Commissioner.

Major Oldfield said the resignation of Mr. Huxham would be received with great regret, particularly as this was due to ill-health. Mr. Huxham had first come out to Ceylon to take up the unpopular task of imposing income tax in the Island. In this capacity, and later as Financial Secretary, he had done an immense amount of work for Ceylon and he moved that the Board should record their appreciation of the services he had rendered to the Institute during the eleven years he had been a member of the Board.

The Board cordially approved this suggestion and the Director was instructed to convey the Board's appreciation to Mr. Huxham.

4. FINANCE

(a) Accounts of the Institute for 1944.

These had been circulated to Members and the Chairman said the Auditors' Reports on these had been considered by the Finance Sub-Committee. The latter body had expressed their satisfaction with the accounts which they recommended for the acceptance of the Board. The Finance Sub-Committee had also recorded their appreciation of the manner in which the accounts had been kept by the Director and his staff.

The Chairman gave details of the comparative results for 1944 and 1943 and invited comments. He called attention to the fact that the Depreciation Reserve of Rs. 556,144 was now covered by cash and liquid assets amounting to Rs. 543,241.

On the motion of Sir Oliver Goonetilleke, seconded by Mr. G. K. Newton, the accounts of the Institute, the Junior Staff Provident Fund and the Medical Fund for 1944 with the Auditors' Report thereon were approved and accepted unanimously.

(b) Accounts of the Institute to 31st March, 1945.

These had been circulated to members

The Chairman referred to the cash balance on current account and said that by the 30th April, 1945, this had been reduced to Rs. 31,000. This was of course chiefly due to the small crop obtained in the first three months of the year. In these circumstances no further investment of the Institute's funds could be made at present.

In reply to the Financial Secretary, the Chairman gave details of the Fixed Deposits amounting to Rs. 114,119. It was agreed these should not be disturbed.

In reply to Major Oldfield, the Director stated that the receipts from the cess to 31st March, 1945, were approximately Rs. 17,000 below the figure for 1944.

In reply to the Director of Agriculture, the Director explained the item "Funds overspent."

The accounts to 31st March, 1945, were approved and recorded.

(c) Additional Votes.

The Board sanctioned the following additional votes which had been recommended by the Finance Sub-Committee.

(i) Research, Vote 57, Water Supply.— Rs. 700 for renewal of part of the pipe line.

(ii) Estate, Capital. Vote 85, Other Buildings.—Rs. 670 for construction of a permanent roof to the Manure Shed in Field No. 3.

(iii) Estate Working Account. Vote 17, Insurance.—Rs. 3,000. The Chairman explained that the rate of premium on the factory and machinery had been increased by 66 per cent as from 1st May, 1945, and that it was also necessary to increase the cover on the factory buildings to 250 per cent above pre-war valuation and of machinery to 125 per cent above that figure.

The Chairman said the premium on the factory would be reduced by 66 per cent when the Sprinkler System was installed. It was hoped this would not be unduly delayed.

5. ST. COOMBS ESTATE

(a) Visiting Agent's Report dated 19th February, 1945.

This was accepted and recorded.

Reported that Mr. Tonks was shortly proceeding on leave, and it would be necessary to appoint an acting Visiting Agent.

The Board authorised the Chairman, the Visiting Agent and the Director to make the necessary arrangements.

(b) St. Coombs Caddai.

The Chairman explained that difficulty was being experienced in regard to the vacating of the Caddai buildings by the Caddai owner. The latter had been given notice in August, 1944, to vacate the buildings on the 31st March, 1945, but had not done so and ignored all correspondence.

The Director said the papers had been referred to Messrs. Julius & Creasy who were going into the matter.

(c) St. Coombs Results to 31st March, 1945.

The Chairman reported that, in the first three months of 1945, St. Coombs had experienced the worst drought in its history. As a result, crop figures were naturally most disappointing; the yield to 31st March, being only 30,850 lb. as against 61,879 lb. for the same period in 1944. In April 15,752 lbs. had been obtained compared with 19,056 lb. in 1944. Rain had been recorded in April and crop was coming in well in May. He said the future crop position was, however, very uncertain as only 1.35 inches of rain had been recorded in May up to the 24th.

(d) Acting Superintendent, St. Coombs

The Board authorised the Chairman, Visiting Agent and the Director to make necessary arrangements for an acting appointment on St. Coombs for the period of Mr. Rogers' furlough.

6. ESTATE AND EXPERIMENTAL SUB-COMMITTEE MINUTES OF MEETING HELD 27-4-45

The Chairman called special attention to that part of the Minutes dealing with the manufacture of tea from unwithered leaf and said this process, though still in the development stage, seemed likely to be of the greatest importance to the Industry. He asked Mr. Lamb to give further details of the process.

Mr. Lamb briefly outlined the process of manufacture and exhibited samples of tea made from unwithered leaf. He stressed the considerable saving in cost of manufacture which would result from this or a similar process, and the advantage of being able to dispense with withering lofts which were the chief fire risk in factories.

In reply to Mr. Amarasuriya, Mr. Lamb said the process had not yet been tried on low-country leaf but it was hoped to make arrangements for this to be done at an early date.

Mr. Lamb stated in reply to Mr. Gourlay that there was no reason to think tea so made would be inferior in keeping quality; on the contrary, it was likely it would be better than normal tea in this respect.

The Chairman said the Board would appreciate the great potentialities of this interesting process for which Mr. Lamb deserved the highest praise. The Experimental Sub-Committee had strongly recommended that the process should be protected from exploitation by outside bodies against the general interests of the Industry. Messrs. Julius & Creasy had been consulted and were definitely of opinion that a provisional patent should be applied for immediately by the Board of the Institute.

The Director made it clear that there was no intention of utilising this patent, if obtained, for the purpose of obtaining fees. Estates would be empowered to make use of this process once this had become commercially practical.

The Board unanimously authorised the Director to apply for a patent on the lines indicated above.

7. REPORT OF SUB-COMMITTEE *RE* GENERAL CONDITIONS OF SERVICE OF INSTITUTE'S JUNIOR AND SUB-STAFF

The report of the Sub-Committee, dated the 17th April, 1945, had been issued to Members together with a Memorandum of the Director dated the 29th March, 1945.

The Chairman said the Committee was unanimously of opinion that improvements in the salary scales of most grades of the Junior and Subordinate Staff were urgently necessary, as in many cases these were not in accord with modern conditions.

In addition to changes in the scales, the Committee agreed with the Director, *vide* Paragraphs 3 and 4 of the Director's Memorandum of the 29th March, that certain adjustments in the grading of individual employees should be made at the discretion of the Director.

The total cost in the present year of the proposals made by the Committee, inclusive of the above changes in grading, would amount to approximately Rs. 7,500 on a present salary vote of Rs. 72,790, an increase of approximately 10 per cent in salary cost. In addition there would be an increase under Provident Fund Contributions of Rs. 748.

The Chairman said the salary scales given referred to basic salaries only, exclusive of dearness allowance. In addition, he reminded the Board that the St. Coombs Estate Staff, apart from dearness allowances received none of the usual estate allowances, such as a labour allowance, free firewood or tea.

Mr. Scott said the Committee proposed that any changes approved by the Board should have effect as from 1st January, 1945.

The Board then considered the report section by section, the following comments being made :—

Estate Staff.

Teamaker.—The Chairman said that it was suggested the allowance payable by the Research side should be Rs. 25 per mensem. The Financial Secretary favoured payment of an annual bonus instead of an allowance but, after hearing further details of the responsibilities of the Teamaker in regard to experimental work, withdrew his objection. The new salary scales for the estate staff were then approved.

Research Staff.

Laboratory Assistants.—It was agreed that the new scales were suitable. The Financial Secretary, however, urged that any regrading of the staff should receive the prior approval of the Board. After discussion, it was agreed that the Director should submit his detailed proposals to the next meeting of the Board.

Smallholdings Officers.—The Board were of opinion that the present rate of mileage allowance, 25 cents per mile, payable to the Smallholdings Officers was inadequate and authorised the raising of this allowance to 35 cents per mile. The Board decided to make no change in the rates of house allowances payable to these officers.

Subordinate Staff.

Considerable discussion took place on the necessity for any efficiency bars in the salary scales proposed for the Laboratory attendants, office peon and water mechanic. Eventually, Mr. Newton dissenting, it was agreed these should be removed, one continuous scale being adopted in each case.

On the motion of the Financial Secretary, seconded by Mr. Gourlay, the Board then unanimously approved the report of the Sub-Committee as amended by the decisions above recorded, all changes to have effect as from 1st January, 1945.

The Director was asked to place details of his regrading proposals before the next meeting of the Board for consideration and confirmation.

Arising from the discussion on the Smallholdings Officers, Mr. Kannangara urged that arrangements should be made for Mr. Tillekeratne to work in the Morawak Korale. The Director said he would examine the question.

(Major Oldfield left the Meeting at this stage).

(b) Laboratory Assistant, Biochemical Department.

The Director was authorised to fill the vacancy caused by the retirement of Mr. P. R. Perera.

8. SENIOR SCIENTIFIC STAFF

(a) The Board approved the new draft of Clause 4 of senior officers' agreements as prepared by Messrs. Julius & Creasy.

The Board authorised the signing and sealing of Mr. Lamb's agreement which had been held up pending a decision regarding the above clause

(b) Leave Arrangements.

(i) Reported that Dr. Eden's return from Australia would be delayed owing to difficulties in obtaining a passage.

The Director referred to correspondence with Dr. Eden on the question of this extended leave, and the Board confirmed the Director's ruling that the extra term must count against Dr. Eden's ordinary leave quota and could not be counted as study leave.

(ii) The Board approved the grant of nine months' leave in Europe due to Dr. T. E. T. Bond, Assistant Mycologist, under the terms of his agreement, such leave to be taken in July or when a passage becomes available.

(iii) Military Service — Mr. J. Lamb. —Reported that, in view of the fact that Mr. Lamb had been released from military service at the request of the Board, no military leave had been granted to Mr. Lamb.

After discussion, the Board decided on the motion of the Financial Secretary, seconded by Mr. Kannangara, that, in the above circumstances, Mr. Lamb's period of military service, 1 year and 10 months, should count as service earning Institute leave.

9. ANNUAL REPORT OF THE BOARD FOR 1944

The Board approved the Draft Report of the Board for 1944.

10. ANY OTHER BUSINESS

(i) Tea Seed Bearers.

Considered letter from the Superintendent, Katugastota Estate, pointing out that this estate was being taken over by Government for the purpose of a Village Expansion Scheme, and suggesting that the Institute should apply to the Land Commissioner for the Nakkhattyia tea seed bearers on the estate to be handed over to the Institute and maintained by the latter.

After a short discussion it was decided this proposal was impracticable and the Director was directed to reply accordingly.

(ii) Meetings of the Board.

The Chairman referred to the fact that it had not been possible to hold the meeting of the Board to be held at *St. Coombs* on the 27th April as most of the Colombo members had found themselves unable to get away. He stressed the importance of holding at least one meeting annually at St. Coombs to promote contact between the Board and the Scientific Staff.

The Board agreed this was desirable and the Financial Secretary suggested the December meeting might be held at St. Coombs. The Chairman agreed to consider this.

(iii) Travelling Allowances of the Board.

Mr. Kannangara considered the mileage rate of 35 cents per mile payable to Board Members when travelling on Institute business was inadequate in present circumstances and proposed this be increased to 45 cents.

After a short discussion, it was decided the Director should ascertain what rates are being paid by other Institutes and Boards and that the matter should be further discussed at the next meeting.

The meeting then concluded with a vote of thanks to the Chair.

(Sgd.) ROLAND V. NORRIS,
Secretary

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 17-8-45

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Tea Propaganda Board's Office, Colombo, on Friday, the 17th August ,1945, at 2-30 p.m.

Present.—Mr. R. C. Scott, C.B.E. (Chairman), the Hon'ble the Financial Secretary (Sir Oliver E. Goonetilleke, K.B.E., C.M.G.); the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.); the Acting Chairman, Planters' Association of Ceylon (Mr. R. Singleton Salmon); the Chairman, Ceylon Estates Proprietary Association (Mr. E. E. Spencer); Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs. F. Amarasuriya, R. C. Kannangara, M.S.C., H. S. Hurst and Dr. R. V. Norris (Director and Secretary).

(1). The Notice convening the Meeting was read.

(2). The Minutes of the Meeting of the Board held on the 25th May, 1945, were confirmed.

Before proceeding with the business on the Agenda, Major J. W. Oldfield on behalf of the Board referred to the Commandership of the Order of the British Empire which had been conferred on Mr. R. C. Scott. Major Oldfield said this well merited honour had given much pleasure both to the Board and to the public generally.

Mr. Scott suitably replied.

The Chairman apologised to the Board for the fact that the meeting had to be held on V.-J. Day. In view of the fact that the date of the meeting had already been postponed once, he had felt it could not be further delayed.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

Board.—(a) Reported that Mr. E. E. Spencer had become an ex-officio member of the Board as from 1st July on taking over the Chairmanship of the Ceylon Estates Proprietary Association.

(b) Reported that Mr. G. K. Newton, Chairman of the Planters' Association of Ceylon, had proceeded on home leave as from the 1st July and Mr. R. Singleton Salmon, previously a nominated member, was now acting as Chairman and so became an ex-officio member.

(c) Reported that to fill the acting vacancy thus created, the Planters' Association of Ceylon had nominated Mr. H. S. Hurst.

(d) The Chairman then announced that a letter had been received from Mr. R. G. Coombe submitting with great regret his resignation from the Board, due to ill-health and the consequent difficulty in attending meetings in Colombo. Mr. Scott said all members of the Board would be extremely sorry to hear this news. Mr. Coombe had been most intimately concerned with the setting up of the Tea Research Institute and had been continuously on the Board since this was formed. Early in 1927 he became the second Chairman in succession to Major Oldfield and he had held that office for seven years. Everyone who had served on the Board realised the ungrudging time and interest Mr. Coombe had always given to the affairs of the Institute. He felt sure the Board would wish to record a resolution expressing their great regret at Mr. Coombe's resignation and their very deep appreciation of his valuable services to the Institute. Mr. Scott's remarks were received with applause and the Director was instructed to send a copy of these to Mr. Coombe.

Estate and Experimental Sub-Committee.

The Chairman announced that Mr. Coombe would continue to serve as a member of the Estate and Experimental Sub-Committee.

The Board confirmed the nomination to the above Committee, of Mr. H. S. Hurst to act for Mr. G. K. Newton during the latter's absence on leave.

4. FINANCE

The accounts of the Institute to the 30th June had been issued to Members, and the Chairman briefly summarised the position.

5. SENIOR SCIENTIFIC STAFF

(a) Reported that Dr. T. Eden, Agricultural Chemist, had returned from leave on the 31st July.

(b) Reported that Dr. T. E. T. Bond, Assistant Mycologist, had proceeded on home leave on the 31st July.

(c) The Chairman said the Director had received a letter from Major Redman King, the Institute's Entomologist, who was now on service. In this Major King said that, owing to the specialised nature of his duties, he was not likely to be released in the near

future and, in view of his age and the strain of his war service, he did not feel he would be able to carry on after the war.

6. JUNIOR SCIENTIFIC STAFF

Arising from the report of the Sub-Committee appointed to consider the conditions of service of the Research and Estate Junior and Subordinate Staff, the Board considered the Director's proposals in regard to the grading and actual salaries to be allowed to these employees as from 1st January, 1945, as indicated in the Director's Memo. dated 11th August, 1945, which had been issued to all members of the Board.

After hearing further details from the Director in regard to certain officers, the Board unanimously approved the Director's proposals in regard to the following classes of employees: Assistant Entomologist, Research Assistants, Small-Holdings Officers, Laboratory Assistants, Clerical Staff and Estate Staff.

With regard to the Research Subordinate Staff, the Financial Secretary suggested the increase might be made on the general basis of two increments, subject to such modification as seemed reasonable in the case of two employees regarding whom the Director had made special comment. It was unanimously decided this should be done, the above adjustments to be left to the Director in consultation with the Chairman.

7. ST. COOMBS ESTATE

(a) The Board approved the following acting arrangements during Mr. Rogers' absence on leave: Dr. T. Eden to be in charge of the estate, in addition to his own duties, with Mr. F. P. Jayewardene as Field Assistant.

(b) *Visiting Agent.*—The Board approved the appointment of Mr. A. H. Hall of Dammeria Estate, Passara, as Visiting Agent, *vice* Mr. H. Tonks resigned, the appointment to be on the same terms as those previously in force.

The Board recorded a very cordial vote of thanks to Mr. Tonks for his valuable service as Visiting Agent and Member of the Estate and Experimental Sub-Committee. The Chairman said all would regret the severance of Mr. Tonks' connection with the Institute and on behalf of the Board he wished Mr. and Mrs. Tonks a very happy retirement.

(c) *Visiting Agent's Report dated the 18th June, 1945.*—This had been circulated to members. In reply to Major Oldfield, the Chairman said the question of the improvement of existing lines would have consideration as also the total accommodation required.

8. MINUTES OF THE MEETING OF THE ESTATE AND EXPERIMENTAL SUB-COMMITTEE HELD 27-7-45

(a) *Tea Manufacture.*—The Director reported that triplicate sets of samples of the tea made by the new process had been sent to the Ceylon Association in London for report and comment by the various interests concerned, including the International Tea Market Expansion Board. It was also reported that a provisional application for a patent in the name of the Board had also been filed.

A few examples of teas made by the new process were shewn to the Board.

(b) *Factory Fires.*—In reference to the suggestions made by the Experimental Committee on this subject, Mr. Hurst and others enquired as to the feasibility of using ½-in. wire mesh instead of hessian. Mr. Hurst said there seemed to be a prejudice in Ceylon against wire mesh on the grounds that the leaf was damaged during removal. The Director said it would be of little importance if the leaf were damaged at that stage, immediately prior to rolling. Damage in spreading would be more serious but he did not see why it should occur. Mr. Morford, who was present at the meeting of the

Experimental Committee, had had considerable experience with wire mesh tats and had not experienced any difficulty in their use. Wire mesh withering tats were very common in Java. It was important however that the galvanising of the mesh should be of good quality. The Chairman said it was intended to install one bank of wire mesh tats at St. Coombs for trial.

9. TRAVELLING ALLOWANCES TO BOARD MEMBERS

The Board decided that the mileage rates paid to members of the Board should be increased to 45 cents per mile.

10. ANY OTHER BUSINESS

(a) In reply to Mr. R. C. Kannangara, the Director said he was considering how assistance could be afforded to small-holders in the Morawak Korale area and he had already discussed this with the Small-Holdings Officer, Baddegama. Dr. Norris said he would be attending the next meeting of the Morawak Korale District Planters' Association when he would go further into the matter.

(b) *V.-J. Day.*—The Board approved the recommendation that all estate labourers at St. Coombs should be granted a full holiday on Saturday, August 25th, in celebration of V.-J. Day, receiving pay however for the day at the rates of Rs. 2, Rs. 1-50 and Re. 1 for men, women and working children respectively.

The Meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,
Secretary.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 22-11-45

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Tea Propaganda Board Offices, Prince Street, Colombo, on Thursday, the 22nd, November, 1945, at 2-30 p.m.

Present.—The Chairman, T. R. I. (Mr. R. C. Scott, C.B.E.); the Deputy-Financial Secretary (Mr. C. J. D. Lanktree, C.B.E., E.D., C.C.S.) representing the Financial Secretary; the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.); the Chairman, Planters' Association of Ceylon (Mr. R. Singleton Salmon); Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs. J. C. Kelly, W. H. Gourlay, F. Amarasuriya and Dr. R. V. Norris (Director and Secretary).

Apologies for absence were received from the Chairman, C.E.P.A., Mr. H. S. Hurst and Mr. Gorton Coombe.

(1). The Notice convening the Meeting was read.

(2). The Minutes of the Meeting of the Board held on the 17th August, 1945, were confirmed and signed by the Chairman.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

Board.—Reported that Mr. Gorton Coombe had been nominated by the Planters' Association of Ceylon as one of their representatives with effect from the 16th November, 1945, to fill the vacancy created by the resignation of Mr. R. G. Coombe.

Finance Committee.—On the motion of Mr. Gourlay, who was seconded by Mr. Kelly, Mr. H. S. Hurst was unanimously elected to the Finance Committee to fill the existing vacancy.

4. FINANCE

(i) Institute's Accounts to the 30th September, 1945.—The Chairman pointed out that since the accounts were made out, a sum of Rs. 50,000 had been placed on Fixed Deposit against Loan Payments due in 1946. With regard to the Estate Working Account, Mr. Scott said it was anticipated the final profits on the Estate for 1945 would be about Rs. 37,500. The accounts were accepted.

(ii) Revised Forecast of Receipts and Expenditure for 1945.—This was accepted ; it being noted that it was estimated there would be a surplus on Revenue Account of about Rs. 52,300.

(iii) Estimates of Receipts and Expenditure for 1946.—This was accepted subject to a small correction in the figure shewn under Estate Capital Expenditure.

(iv) Research and Estate Estimates for 1946.—The Chairman said these estimates had been scrutinized by the Finance Committee, which recommended their acceptance subject to an increase in the Estate Estimates of Rs. 900 under 'Insurances' to provide for additional cover under the Loss of Profits Policy.

The Chairman explained that the estimates must be regarded as somewhat provisional, particularly in regard to capital expenditure, and called attention to the explanatory Memorandum by the Director on this subject.

He also asked the Board to note the Director's recommendation that no immediate steps should be taken to recruit a Senior Staff Officer in place of Mr. King. The Director's proposal was that Dr. Gadd should be transferred and appointed Entomologist ; Dr. Bond, Assistant Mycologist, becoming Mycologist. No additional expenditure was involved by these changes. It would also be noted that provision had been made in the Research Estimates for an additional Small-Holdings Officer.

In the discussion which followed, the Director in reply to the Director of Agriculture, gave details of work on soil erosion on St. Coombs. With regard to the estate estimates, Mr. Kelly suggested that it was possible the proposed cover under the Loss of Profits Policy was too great, and he undertook to look into the matter. Meantime it was agreed the increase of Rs. 900 in the estimates should stand.

On the proposal of Mr. Gourlay, seconded by the Director of Agriculture, the Research and Estate Estimates as amended by the Finance Committee were approved unanimously.

5. POLICY IN REGARD TO FUTURE DEVELOPMENT

A Memorandum by the Director on this subject was before the Board. In this Dr. Norris asked the Board to appoint a Sub-Committee to consider :—

(i) Probable lines of development in the Institute's future work and the staff and equipment required for this ; and

(ii) Future requirements in regard to buildings and capital expenditure generally ; and to assess the priority which should be given to different items.

In regard to (i), Dr. Norris referred to the demand for a Sub-Station in the low-country.

The Chairman said the Finance Committee had suggested that the Estate and the Experimental Sub-Committee would be the appropriate body to consider these questions and make recommendations.

The Director of Agriculture said that it was necessary that a clear direction should be given to the Sub-Committee to draft the proposals, having some regard to what was happening outside. As instances of the absence of that familiarity with outside affairs he called attention to the facts

that no steps had been taken to provide facilities for Research Students and that a request for the preparation of a handbook on tea production had not been given effect to, although the suggestions originated from the Hon'ble the Minister.

The Chairman, in reply, asked Mr. Seneviratne, and any other members of the Board who wished to do so, to send in suggestions in regard to the future development of the Institute to the Director. Such suggestions would then be considered by the Committee appointed.

After further discussion it was decided unanimously on the motion of Major Oldfield, seconded by Mr. Gourlay, that the Estate and Experimental Sub-Committee should be asked to report on these questions, the Committee being given full power to co-opt other persons to assist them.

Passara Sub-Station.—The Director reported that, under the terms of the agreement with Messrs. George Steuart & Co., and Gonakelle Estate, the buildings of the Passara Sub-Station would become the property of Gonakelle Estate at the end of 1945. The Institute, however, had the option of occupying and using these buildings for so long as they might wish to do so on payment to Gonakelle Estate of a nominal rent of Re. 1 per annum.

The Director said these buildings had been fully depreciated and would be written off in the 1945 accounts.

The Board authorised the Director to inform Messrs. George Steuart & Co. that the Institute wished to take up the above option.

Minutes of the Meeting of the Estate and Experimental Sub-Committee held on November 10, 1945.

(a) St. Coombs Estate.—The report of the Visiting Agent dated the 22nd October, 1945, was accepted and recorded.

(b) Experimental Tea Manufacture.

(i) New Process of Tea Manufacture.—The Director said the reports on the samples sent to London were disappointing. It was unfortunate that attention seemed chiefly to be focussed on the question of compressing the tea in tablet form. From the producers' point of view the most interesting point in the process was the elimination of withering and the shortening of the time required to manufacture.

In reply to Major Oldfield, the Director said he had been disappointed by the attitude taken up by the International Tea Market Expansion Board. In particular, he thought Mr. Huxley's observations were somewhat unfair to the Institute in view of the fact that these were apparently made before Mr. Huxley had seen the notes on the new process, which had been sent to the Ceylon Association for issue to those to be consulted.

Dr. Norris went on to say the Institute fully realised that blending was essential to the Industry, and, further, that it was desirable to aim at types of tea generally similar to those now accepted by the Industry. Work was proceeding on these lines and appreciable progress had already been made in improving the appearance of the experimental teas and reducing the "brassy" character which had been complained of.

The Chairman confirmed the Director's remarks, and said the progress recently made was distinctly encouraging.

The Director said it had been proposed to issue details of the new process in an article in the *Tea Quarterly* which was already in proof. In view of the feeling in London in regard to publicity and the fact that considerable modifications would be required in the process, he thought it would be wiser to withdraw this number. The Board agreed this should be done.

(ii) Cone Rolling.—The Experimental Sub-Committee had recommended that cone rolling should be adopted in St. Coombs commercial manufacture.

In reply to questions by Major Oldfield and Mr. Kelly, the Director said that, in the opinion of the Institute, cone rolling was a definite advance in technique. The actual design of the cones for any particular type of roller was, however, a matter which required technical advice as small variations had a most marked effect on dhool production. Commercial firms should now be in a position to give such advice.

Mr. Scott said he was most strongly in favour of cone rolling which had, in his experience, given most excellent results, leading to improved teas with no increase in power consumption.

The Board approved of cone rolling being adopted in St. Coombs factory.

7. SENIOR SCIENTIFIC STAFF

(a) Lt.-Col. F. R. Tubbs (Plant Physiologist).—Reported that Lt.-Col. Tubbs, Plant Physiologist, was now on leave pending demobilisation and was expected back in Ceylon during December.

The Board authorised the fixing of the Institute's seal to this Officer's new agreement.

(b) Mr. J. Lamb (Biochemist).—The Board sanctioned nine months' home leave to Mr. J. Lamb, Biochemist, with effect from February or date of sailing.

It was decided that the Director should take over general charge of the Biochemical Department during Mr. Lamb's absence, with Mr. S. Sreerangachar, Research Assistant, in immediate charge of the laboratory side of the work, an allowance of Rs. 75 per mensem being granted to Mr. Sreerangachar.

Reported that, as sanctioned by the Board, the Institute's seal had been affixed to Mr. Lamb's new agreement on the 10th November, 1945, in the presence of two members of the Board and the Director.

8. JUNIOR SCIENTIFIC STAFF

(i) The Board approved the appointment of Mr. S. M. Guneratnam as Assistant in the Biochemical Department on a starting salary of Rs. 120 in the normal scale of such appointments, to fill the existing vacancy in the staff of the Department.

(ii) Reported that Mr. R. L. Illankoon, Small-Holdings Officer, was likely to be released from military service during December. In these circumstances provisional notice had been given to Mr. Boange who had been acting for Mr. Illankoon. As work on small-holdings was to be expanded, probably it would be possible to retain Mr. Boange.

(iii) *Mr. P. R. Perera.*—Reported that a letter had been received from the mother of Mr. P. R. Perera, former Assistant in the Biochemical Department, asking the Board for some compassionate grant to her son who had been invalidated out of the Institute's service in 1944.

The Director was asked to obtain details of the procedure adopted in Government service in similar cases, and to bring up the matter again at the next meeting of the Board.

9. ANY OTHER BUSINESS

(i) *Next Board Meeting.*—In view of the difficulty in obtaining a quorum for a meeting to be held at St. Coombs, it was decided that the next meeting of the Board should be held in Colombo on Thursday, the 20th December, at 2-30 p.m.

(ii) A vote of thanks was recorded to the Ceylon Tea Propaganda Board for the use of their Board Room for T. R. I. meetings and for the tea kindly provided on such occasions.

The Meeting concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS.
Secretary

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. C. Scott, C.B.E., (Chairman).

(2) Mr. H. S. Hurst

(3) Mr. Gorton Coombe

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C., M.S.C.

(5) Mr. J. C. Kelly

(6) Mr. D. T. Richards

(C) Representing the Low-Country Products' Association :—

(7) Mr. F. Amarasuriya

(D) Representing the Small-Holders :—

(8) Mr. R. C. Kannangara, M.S.C.

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) The Chairman, Ceylon Estates Proprietary Association.

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

CONTENTS.

		Page
(1)	Norris, R. V.—Fertiliser Rationing, 1946 ...	1
(2)	Gadd, C. H. and Loos, C. A.—The Problem of Nematode Control in Tea Plantations ...	3
(3)	Eden, T.—Research in Relation to Advisory Work	12
(4)	Eden, T.—Recent Views on Soil Fertility ...	15
(5)	Lamb, J.—A Review of Rolling Methods in Tea Manufacture	19
(6)	—— Minutes of Meetings of the Board held on the 25th May, 1945; 17th August, 1945; and 22nd November, 1945.	29

The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.